

EXHIBIT 11

**IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MARYLAND**

MARYLAND SHALL ISSUE, INC., *et al.*, *

Plaintiffs, *
v. * Civil Case No. 16-cv-3311-ELH
LAWRENCE HOGAN, et al., *
Defendants. *

* * * * *

DECLARATION OF DANIEL W. WEBSTER

I, Daniel W. Webster, under penalty of perjury, declare and state:

1. I am Professor of Health Policy and Management, Director of the Health and Public Policy Ph.D. Program, Deputy Director for Research at the Center for the Prevention of Youth Violence, and Director of the Johns Hopkins Center for Gun Policy and Research at the Johns Hopkins Bloomberg School of Public Health. I am more than 18 years of age and am competent to testify, upon personal knowledge, to the matters stated below.

2. I began my career in public safety research in 1985 as a Research Associate at the University of Michigan's School of Public Health, and have devoted most of my research since then to gun-related injuries and violence. I have a Master of Public Health degree from the University of Michigan and a doctorate in Health Policy and Management from the Johns Hopkins School of Public Health. This graduate training included many advanced courses in epidemiology, research methods, and statistical analysis.

3. Immediately prior to joining the faculty at Johns Hopkins, I directed a program on violence research at the Washington (D.C.) Hospital Center. I joined the faculty of the Johns Hopkins School of Public Health in 1992, and since 2010 have been a tenured Professor of Health Policy and Management with a joint appointment in the School of Education's Division of Public Safety Leadership. I teach graduate courses on violence prevention and research and evaluation methods at Johns Hopkins, direct the PhD program in Health and Public Policy, and serve on the steering committee of a pre- and post-doctoral training program in violence prevention research funded by the National Institutes of Health.

4. I have directed numerous studies related to gun violence and its prevention. I have published 121 articles in scientific, peer-reviewed journals, the vast majority of these addressed some aspect of violence and/or firearm injuries and their prevention. I am the lead editor of a recent book entitled Reducing Gun Violence in America: Informing Policy with Evidence and Analysis by Johns Hopkins University Press (2013), and I am the lead author for two chapters and co-author on three other chapters in this book. My curriculum vitae, detailing these publications, is attached as Exhibit 1 to this Declaration.

5. The Johns Hopkins Center for Gun Policy and Research was established to conduct rigorous research into gun policy questions, look objectively at all available data, and analyze and report the results. Where the data and research, considered objectively, support a particular policy, we say so. Where the data and research do not support a particular policy, we say that as well. Our goal is not to advance any particular policy or agenda, but to use data and research to inform public policy decisions.

6. I have been retained by the State of Maryland to render expert opinions in this case. I make this declaration on the basis of my training and expertise, the research discussed herein and in my expert report attached hereto as Exhibit 2, and the work that I have done in this case to date.

7. It is my opinion that laws that require citizens to obtain a permit to purchase a firearm (“PTP” laws), including Maryland’s requirement for a handgun qualification license (“HQL”), promote public safety and reduce firearms violence.

8. PTP laws are designed to reduce firearms violence in several ways. First, such laws discourage the diversion of legally-purchased firearms for criminal use by way of “straw purchases.” Straw purchases are transactions in which persons who are legally prohibited from purchasing a firearm (due to criminal history or other disqualifying events) recruit third-parties to purchase guns for them.

9. Without a PTP law, these straw purchases can be relatively quick, low-risk transactions. By contrast, many PTP laws, including Maryland’s HQL law, require prospective purchasers to be fingerprinted and complete firearms safety training. This increases the risk, time and money required to complete an illegal straw purchase and is therefore likely to deter individuals from participating in such a transaction.

10. Fingerprinting of firearms purchasers also promotes public safety by enabling law enforcement agencies to identify HQL holders who are subsequently convicted of offenses that disqualify them from owning a handgun. This allows police to remove firearms from the possession of such criminals.

11. Maryland's HQL law also promotes public safety and reduces firearms violence by requiring applicants to complete a four-hour firearms safety training course that includes instruction on the proper way to store handguns. This training is designed to increase proper firearm storage practices in the home and reduce the risk of accidental shootings, teen suicides, and shootings by troubled teens in schools and other settings. The majority of school shootings are committed by minors with guns brought from their homes. Surveys of gun owners show that unsafe gun storage is common and that gun owners who complete firearms safety training are more likely to store their guns locked and unloaded.

12. PTP laws can also reduce firearms violence by reducing impulse purchases of firearms by individuals who are angry or despondent and are considering taking a life. Requiring purchasers to be fingerprinted and take safety training means that purchasers need to engage in planning over a number of days, which can result in impulse buyers changing their minds. This is particularly important in the case of suicides because many suicidal acts take place within minutes or hours of a suicidal thought.

13. As set forth in my expert report, attached hereto as Exhibit 2, empirical evidence demonstrates that PTP laws are an effective means of reducing (1) the diversion of guns for criminal purposes;¹ (2) firearm homicides; and (3) suicides with firearms. Data also suggests that PTP laws may reduce serious injuries and death among law enforcement officers.

¹ Exhibit 3, Daniel Webster *et al.*, *Preventing the Diversion of Guns to Criminals through Effective Firearm Sales Laws*, in *Reducing Gun Violence in America: Informing Policy with Evidence and Analysis* 109-22 (Webster, *et al.*, eds., Johns Hopkins Univ. Press 2013)

14. A study of Connecticut's PTP law found that the licensing requirement to purchase a firearm was associated with a statistically significant reduction in Connecticut's firearm homicide rates during the first decade that the law was in place, with no similar reduction in non-firearm homicides.² Connecticut's law has features similar to Maryland's, including a requirement that applicants be fingerprinted for enhanced background checks for handguns sold by private sellers and licensed firearm dealers, and a requirement that applicants complete an approved handgun safety course.

15. By contrast, another study showed an abrupt increase in firearm-related homicides in Missouri after that state repealed its handgun licensing requirement in 2007. The increase in firearm-related homicide in Missouri occurred at a time when there was no similar increase in surrounding states or the nation as a whole, and the state experienced an increase in the percentage of crime guns recovered by police that had been originally sold by in-state retailers.³

16. Studies of Missouri's and Connecticut's laws also have found the presence of firearm licensing requirements to be associated with lower rates of firearm-related suicides.⁴

² Exhibit 4, Kara E. Rudolph, *et al.*, *Association Between Connecticut's Permit-to-Purchase Handgun Law and Homicides*, 105 Am. J. of Public Health 8, e49 (Aug. 2015).

³ Exhibit 5, Daniel Webster, *et al.*, *Effects of the Repeal of Missouri's Handgun Purchaser Licensing Law on Homicides*, 91 J. of Urban Health 2, 293 (2014).

⁴ Exhibit 6, Cassandra K. Crifasi, *et al.*, *Effects of Changes in Permit-to-Purchase Handgun Laws in Connecticut and Missouri on Suicide Rates*, 79 Preventive medicine 43 (2015).

17. My colleagues and I studied the effects of several state firearm policies on homicide rates in large urban counties and found that adopting permit to purchase (PTP) requirements for handguns was associated with a statistically significant 11% reduction in firearm homicide rates. Using the data from this study, I derived separate estimates for the initial effects of Maryland's Firearm Safety Act ("FSA") that included the HQL requirement on homicide rates. Because the study period included 2015, when firearm homicide rates surges in Baltimore City immediately following the riots over the in-custody death of Freddie Gray, Jr., estimates of the law's impacts in Baltimore or statewide would be biased in the direction of more homicides due to the historical confounder of major riots. Therefore, we specified statistical models that allowed the effects of the FSA/HQL requirement to vary between Baltimore City and the other large urban counties (Anne Arundel, Baltimore, Montgomery, and Prince Georges). The model estimates a statistically significant ($p < .001$) 48 percent reduction in firearm homicide rates in these large urban counties associated with Maryland's FSA law and HQL requirement and 28 percent higher firearm homicide rates in Baltimore City (due to the post-riot surge).⁵

⁵ Exhibit 7, Cassandra K. Crifasi, *et al.*, *Association between firearm laws and homicide in large, urban U.S. counties*, 95(3) Journal of Urban Health 383-390 (2018). As explained in my supplemental expert report, this analysis reflects revised data submitted in an erratum to the Journal of Urban Health. The estimated effects of the FSA/HQL law on homicide rates in Maryland's large, urban counties did not change in any significant way as a result of the revised data. Under both the original and revised data, the findings revealed an estimated 48 percent reduction in firearm homicide rates in counties other than Baltimore City and a 28 percent increase in Baltimore City. *See Decl. Ex. 2 at 17-18.*

18. I coauthored another recent study assessing the impact of the FSA, which included the HQL requirement, on the supply of handguns diverted to criminal use in Baltimore.⁶ That study showed that the FSA with its HQL requirement was associated with a 76 percent reduction in the number of handguns originally sold in Maryland that were (1) recovered by police in connection with a crime within one year of retail sale; and (2) where the person from whom the gun was recovered was not the same as the person who purchased the gun originally. This shows a strong association between the adoption of Maryland's HQL law and a reduction in the number of handguns diverted to criminals in Baltimore.

19. This study also included data showing that a significant percentage of surveyed criminals in Baltimore believe that the FSA has made it more difficult for criminals to obtain handguns. We surveyed 195 Maryland men who were on parole or probation in May and June of 2016. This was a high-risk population evidenced by the fact that 63 percent reported that they had been shot or shot at, 48 percent had been shot or shot at multiple times. The data showed that 41 percent of these respondents reported that Maryland's new gun law had made it more difficult to obtain a gun, and 40 percent reported that the law had made it more costly to obtain a gun. Of the 172 who responded to the question with a "yes" or "no", 38 percent said the law made it more difficult to get someone to buy a gun on their behalf. These survey findings are consistent with the findings from

⁶ Exhibit 8, Cassandra K. Crifasi *et al.*, *The initial impact of Maryland's Firearm Safety Act of 2013 on the supply of crime guns in Baltimore*, 3(5) The Russel Sage Foundation Journal for the Social Sciences 128-140 (2017).

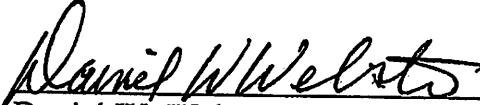
the analyses of crime gun trace data that demonstrate a dramatic decline in guns diverted into the criminal market soon after retail purchase.

20. The evidence and studies set forth in my report show that PTP laws such as Maryland's HQL requirement promote public safety by reducing the diversions of guns from criminal use and by reducing firearm homicides and suicides.

21. It is my opinion that requiring prospective purchasers of handguns to obtain permits for such purchases, such as Maryland's HQL law, is one of the most effective policies for reducing gun violence.

I declare under penalty of perjury that the foregoing is true and correct.

Date: 8-15-18



Daniel W. Webster

Declaration Exhibit 1

November 2017

CURRICULUM VITAE

Daniel William Webster

PERSONAL DATA

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EDUCATION AND TRAINING

Doctor of Science, 1991, The Johns Hopkins University, School of Hygiene and Public Health, Department of Health Policy and Management.

Masters of Public Health, 1985, The University of Michigan, School of Public Health, Department of Health Planning and Administration.

Bachelors of Arts, 1982, The University of Northern Colorado, Psychology.

PROFESSIONAL EXPERIENCE

Bloomberg Professor of American Health, 2018 - . Professor, 2010 – present; Director, Health and Public Policy Program 2013-2015; Associate Professor, 2001-2010; Assistant Professor 1995-2001; Instructor, 1992-1995. Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD.

Professor, 2010 – present, Division of Public Safety Leadership, School of Education, Johns Hopkins University, Baltimore, MD.

Research Center Participation at Johns Hopkins Bloomberg School of Public Health
Center Director, 2012 – present, **Co-Director**, 2001–2012. Johns Hopkins Center for Gun Policy and Research.

Team Co-Lead, 2016 - . Violence Prevention Workgroup, Bloomberg American Health Initiative.

Deputy Dir. for Research, 2005–present, Faculty, 2000-present. Center for the Prevention of Youth Violence.

Core Faculty, 2016 – present. Center for Mental Health and Substance Abuse Policy Research,

Core Faculty, 1992 - present. Center for Injury Research and Policy. JHBSPH.

Director of Violence Research, 1990-1992. Washington Hospital Center, Trauma, Surgical Critical Care, and Emergency Medicine Department, Washington, DC.

Graduate Research/Teaching Assistant, 1987-1990. The Johns Hopkins University, Injury Prevention Center and Department of Pediatrics, Baltimore, MD.

Guest Researcher, 1988. National Institute on Aging; Epidemiology, Demography, and Biometry Program, Bethesda, MD.

Injury Control Analyst, 1986 - 1987. American National Red Cross, Washington, DC.

Research Associate II, 1985 - 1986. Program for Urban Health Research, Department of Epidemiology, School of Public Health, The University of Michigan, Ann Arbor.

Research Associate I, 1984-1985. Systems Analysis Division, The University of Michigan Transportation Research Institute, Ann Arbor.

Research Assistant I, 1983-1984. Department of Health Behavior and Health Education, School of Public Health, The University of Michigan, Ann Arbor.

Social Worker, 1982-1983. Department for Social Services, Cabinet for Human Resources, Commonwealth of Kentucky, Warsaw, Kentucky.

Society Membership and Leadership

American Public Health Association, Injury Control and Emergency Health Services Section, Policy Committee, Faculty for training seminar on Design & Evaluation of Violence Prevention Programs.

American Society of Criminology, Firearms Program Chair 2009.

Participation on Advisory Panels and Task Forces

Founding member and Co-Chair, advisory board for Safe Streets Baltimore, Baltimore City Health Dept., 2016 - present.

Director, Johns Hopkins-Baltimore Collaborative for Violence Reduction, 2016 – present.

Director, Baltimore Homicide Review Commission. City of Baltimore, 2014 – 2015.

Advisory Committee on Violent Media and Gun Violence to the Directorate of the Social, Behavioral and Economic Sciences Division, National Science Foundation, 2013.

Institute of Medicine, Planning Committee for Workshop on Evidentiary Base for Violence Prevention across the Lifespan and Around the World, 2012-2013.

Invited participant to the Baltimore City GunStat project to provide technical assistance to law enforcement officials on gun law enforcement strategies, 2007 to present.

Expert reviewer, Child Death Review Capacity Building Project, Harborview (University of

Washington) Injury Prevention and Research Center, 2006.

Advisory Council to the California Department of Justice for planning gun violence prevention campaign, 2005 - 2009.

Lethality Assessment Committee, advisory group for the Maryland Network Against Domestic Violence to develop a model lethality assessment protocol for police and providers of services to victims of intimate partner violence, 2003 to present.

Johns Hopkins Univ. President's Council on Urban Health, Violence Working Group, 1998-2000.

Baltimore City Task Force on Gunshot Wound Lethality, 1996-1997.

Grant Review

National Center for Injury Control and Prevention, Centers for Disease Control and Prevention, Youth Violence Prevention Through Community-Level Change, April 2004.

National Center for Injury Control and Prevention, Centers for Disease Control and Prevention, May 2001. (Also selected for NCIPC-CDC review panel, June 1998)

National Institutes of Health, Clinical Sciences Special Emphasis Panel, Small Business Innovation Research Program, March 1999.

National Institute for Mental Health, Behavioral Science Track Award for Rapid Transition B/START) Program, April 1998.

Consultations

Violence Prevention Research Program, University of California, Davis, 2014 – present. Identify state background check policies for firearm purchasers and develop plans for evaluating the laws' effects on violence and injuries.

John Jay School of Criminal Justice, 2014 – present. Advise team evaluating Cure Violence public health interventions in New York to reduce shootings and other serious violence.

Police Executive Research Forum, 2012-2014. Advise PERF and law enforcement officials in four cities on strategies to combat gun violence as part of a USDOJ Bureau of Justice Assistance project.

California Dept. of Justice, Firearms Division, 2005-2006. Provide advice about how the state should use funds from its litigation against Wal-Mart to advance gun violence prevention.

The Robert Wood Johnson Foundation, 2005-2006. Prepare advice and white papers on the prevention of youth violence and the prevention of intimate partner violence.

National Association for the Advancement of Colored People, 1999-2000. Assistance with gun violence victimization survey of NAACP members for use in lawsuit against the gun industry.

Duke University and Georgetown University, 1998-1999. Consultation on project to estimate the economic costs associated with firearm injuries.

Consortium of Virginia Urban Municipalities on strategies to reduce violence, 1992.

Center to Prevent Handgun Violence, Washington, DC, 1991-1993. Conducted survey of pediatricians on materials being developed for education families about firearm injury prevention.

Testimony

Testimony before U.S. House Gun Violence Prevention Task Force's Forum: "No More Silence: Commonsense Solutions to Address the Gun Violence Epidemic." December 8, 2015.

Congressional staff briefing on "Guns, Public Health, and Mental Illness: An Evidence-Based Approach to Federal Policy. U.S. House of Representatives, December 11, 2013.

Testimony in Support of SB 281 – Firearm Safety Act of 2013, and SB 266, Maryland Senate Judicial Proceedings Committee, February 6, 2013.

Testimony in support of HB 1092 – Public Safety – Regulated Firearms – Reporting Lost or Stolen. Maryland House of Delegates, Judicial Proceedings Committee Hearings, March 5, 2013

United States House of Representatives Democratic Gun Violence Prevention Task Force on Strengthening Federal Law on Background Checks for Firearm Purchases Friday March 15, 2013.

Proposals to Reduce Gun Violence: Protecting Our Communities While Respecting the Second Amendment. U.S. Senate, Subcommittee on the Constitution, Civil Rights, and Human Rights, February 12, 2013.

Congressional Briefing: Gun Violence: Lessons from Research and Practice. U.S. House of Representatives, February 22, 2012.

Maryland Senate. SB 512, Regulated Firearms – Database – Applications for Dealer's License – Record 2 Keeping and Reporting Requirements. February 23, 2012.

District of Columbia Council, Hearing on gun laws, January 30, 2012.

Maryland Senate and House of Delegates, SB 162 / HB 330, Bill to reduce maximum capacity of detachable ammunition magazines, Feb. – March, 2011.

Maryland Senate and House of Delegates, SB 161 / HB 1043, Bill to provide state police with greater authority to regulate licensed handgun dealers, Feb. – March, 2011.

Maryland Senate and House of Delegates, SB 239 / HB 241, Bill to create a minimum sentence of 18 months for all defendants convicted of illegal possession of a loaded firearm, Feb. – March, 2011.

Maryland Senate and House of Delegates, SB 240 / HB 252, Bill to allow longer sentences for felons illegally possessing firearms and extend prohibitions to include long guns, Feb. – March, 2011.

U.S. House of Representatives, Forum on the Gun Show Loophole Act of 2009. July 14, 2010.

Chicago City Council, Committee on Police and Fire Departments, Hearing on a new legislation to replace the city's handgun ban with comprehensive gun regulations. June 29, 2010.

Maryland Senate and House, SB 645 and HB 820, Firearms Safety Act of 2010, March 2010.

District of Columbia Council, Committee on Public Safety and the Judiciary, Hearing on a bill to rewrite many provisions of its firearms laws. October 1, 2008.

District of Columbia Council, Committee on Public Safety and the Judiciary, Hearing on the revision of the District's gun laws in response to the Supreme Court's ruling that the law was unconstitutional. July 2, 2008.

Maryland Senate, SB 642 Restrictions on pretrial release for offenses involving firearms. Mar. 2008.

Maryland Senate, SB586 Restrictions on Possession of Firearms - Conviction of Disqualifying Crime and Protective Order Respondent, March 2008.

Maryland Senate, SB585 Reporting Lost or Stolen Firearms, March 2008.

Baltimore City Council, Law to Establish a Registry for Gun Offenders, August 2007.

United States Congress, House Committee on Government Oversight and Reform, May 10, 2007.

Connecticut Senate, RB 5600, Act to Require Reporting of Theft or Loss of a Firearm. March 2004.

Maryland Senate, SB 83, Law Enforcement – Forfeited Property and Agency-Owned Handguns – Disposition; SB 528, Firearm Loss and Theft Reporting; SB 494 Assault Weapons Ban; Feb. 2003.

Maryland Senate, SB 224 Gun Accountability Act of 2002; SB 225 Gun Safety Act of 2002; SB 969 Minors Access to Firearms, March 12, 2002.

Maryland Senate, SB 448, Bodywire Evidence and Illegal Gun Sales, February 22, 2002.

Maryland Senate, SB 384, Minors' Access to Firearms - Felony. March 13, 2001.

Maryland House of Delegates, HB 1131, Mandatory Licensing of Handgun Purchasers, March 2000. California State Assembly, Committee on Public Safety, hearing on a right-to-carry handgun law, November 18, 1997. (Written)

Baltimore City Grand Jury Commission on the Prevention of Gun Violence, March 25, 1993.

Maryland Senate, SB 326, Assault Pistols Act of 1993, March 17, 1993.

EDITORIAL ACTIVITIES

Scientific Journal Peer Review

American Journal of Epidemiology

American Journal of Preventive Medicine

American Journal of Public Health
Annals of Emergency Medicine
Annual Reviews of Public Health (Special Symposium Editor 2014-2015)
Archives of Pediatric and Adolescent Medicine
Canadian Medical Association Journal
Epidemiologic Reviews (Special Issue Editor 2015-2016)
Guide to Clinical and Preventive Services
Health Education and Behavior (Special Issue Editorial Board Member)
Health Education Research
Injury Prevention (Editorial Board, 2005-2010)
JAMA (Journal of the American Medical Association)
Journal of Crime and Delinquency
Journal of Criminal Justice
Journal of General and Internal Medicine
Journal of Health Politics, Policy, and Law
Journal of Interpersonal Violence
Journal of Policy Analysis & Management
Journal of Quantitative Criminology
Journal of Trauma
Journal of Urban Health
Journal of Women's Health
New England Journal of Medicine
Pediatrics
Politics and Policy
Preventive Medicine (Co-editor, special issue on gun violence, 2015)
Social Science & Medicine
Southern Economic Journal
Western Criminology Review

HONORS AND AWARDS

Johns Hopkins University Distinguished Alumni Award, 2017.

Injury Free Coalition for Kids, Pioneer Award, 2017.

Leon Robertson Award for best 2016 article in *Injury Epidemiology*, co-author, 2017.

Baltimore City Health Equity Leadership Award, 2016.

David Rall Award for Science-Based Advocacy, American Public Health Association, 2015.

Finalist for The Baltimore Sun's award for Marylander of the Year, 2013.

Selected for Institute of Medicine Planning Committee for the Evidentiary Base for Violence Prevention Across the Lifespan and Around the World Workshop, 2012.

Delta Omega Honorary Society in Public Health – Alpha Chapter, Johns Hopkins Bloomberg School of Public Health, Faculty induction, 2005.

Education Award from the Maryland Network Against Domestic Violence, 2004.

Delta Omega Honorary Society - Alpha Chapter Certificate of Merit, 1989.

William Haddon Memorial Fellowship, The Johns Hopkins School of Public Health, 1988-1989.

Public Health Traineeship, The Johns Hopkins School of Public Health, 1987-1989.

PUBLICATIONS

Peer Reviewed Journal Articles

Crifasi CK, Merrill-Francis M, McCourt A, Vernick JS, Wintemute GJ, **Webster DW**. Association between Firearm Laws and Homicide in Large, Urban U.S. Counties. *Journal of Urban Health*, 2018 May 21. doi: 10.1007/s11524-018-0273-3. [Epub ahead of print] PMID: 29785569.

Barry CL, **Webster DW**, Stone E, Crifasi CK, Vernick JS, McGinty EE. Four Years after Newton: Public Support for Gun Violence Prevention Policies among Gun Owners and Non-Gun Owners. *American Journal of Public Health*. 2018 May 17:e1-e4. doi: 10.2105/AJPH.2018.304432. [Epub ahead of print] PMID: 29771617.

Crifasi CK, McGinty EE, Douchette M, **Webster DW**, Barry CL. Storage practices of U.S. gun owners in 2016. *American Journal of Public Health*, 2018; 108:532-537. doi: 10.2105/AJPH.2017.304262. Epub 2018 Feb 22. PMID: 29470124.

Crifasi CK, Frances M, Vernick JS, **Webster DW**. Changes in the legal environment and enforcement of firearm transfer laws in Pennsylvania and Maryland. *Injury Prevention* January 13, 2018 [Epub ahead of print] doi:10.1136/injuryprev-2017-042582. PMID: 29331990.

Zeoli AM, McCourt A, Buggs S, Lilley D, Frattaroli S, **Webster DW**. Analysis of the strength of legal firearms restrictions for perpetrators of domestic violence and their impact on intimate partner homicide. *American Journal of Epidemiology* 2017 E-pub before print November 29. <https://doi.org/10.1093/aje/kwx362> PMID: 29194475.

Kagawa RM, Rudolph KE, Cerdá M, Castillo AC, Shev BA, **Webster DW**, Vernick JS, Crifasi CK, Wintemute GJ. Repeal of comprehensive background check policies and firearm homicide and suicide. *Epidemiology*, in press.

Castillo AC, Kagawa RM, **Webster DW**, Vernick JS, Cerdá M, Wintemute GJ. Comprehensive Background Check Policy and Firearm Background Checks in Three States. *Injury Prevention* 2017; doi:10.1136/injuryprev-2017-042475.

Webster DW, Buggs SAL. Can an Efficacious Strategy for Curtailing Illegal Drug Sales Be Counted on to Reduce Violent Crime? *Criminology & Public Policy* 2017;16: 821-825.

Stuart EA, Crifasi C, McCourt A, Vernick JS, **Webster D**. Differing perspectives on analyzing data related to firearms and suicide. *American Journal of Public Health*. 2017 Aug;107(8):e26. doi: 10.2105/AJPH.2017.303890.

Crifasi CK, Choksey S, Buggs S, **Webster DW**. The initial impact of Maryland's Firearm Safety Act of 2013 on the supply of crime guns in Baltimore. *The Russel Sage Foundation Journal for the Social Sciences*, in press.

Crifasi CK, Pollack K, **Webster DW**. Assaults against U.S. law enforcement officers in the line-of-duty: Situational context and predictors of lethality. *Injury Epidemiology* 2016; 3:29. PMID: 2785587.

Tung GJ, Vernick JS, Stuart EA, **Webster DW**, Gielen AC. Federal Actions to Incentivize State Adoption of 0.08g/dl Blood Alcohol Concentration Laws. *Injury Prevention* 2016 Oct 31. doi: 10.1136/injuryprev-2016-042087. PMID: 27799290.

Milam AJ, Buggs S*, Furr-Holden CD, Leaf P, Bradshaw CP, **Webster D**. Changes in Attitudes towards Guns and Shootings following Implementation of the Baltimore Safe Streets Intervention. *J Urban Health* 2016 Jun 13. [Epub ahead of print] PMID: 27294969.

Masho SW, Schoeny M, Sigel E, **Webster D**. Outcomes, data, and indicators of violence at the community level. *Journal of Primary Prevention* 2016;37:121-39. doi: 10.1007/s10935-016-0429-4.

Wintemute GJ, Frattaroli S, Wright MA, Claire BE, Vittes KA, **Webster DW**. Firearms and the incidence of arrest among respondents to domestic violence restraining orders. *Injury Epidemiology*, 2015; 2:14. doi: 10.1186/s40621-015-0047-2.

Riedel LE, Barry CL, McGinty EE, Bandara SN, **Webster DW**, Toone RE, Huskamp HA. Improving Health Care Linkages for Persons: The Cook County Jail Medicaid Enrollment Initiative. *J Correct Health Care*. 2016 Jul;22(3):189-99. doi: 10.1177/1078345816653199. PMID: 27302704.

Messing JT, O'Sullivan CS, **Webster D**, Campbell J. Are Abused Women's Protective Actions Associated with Reduced Threats, Stalking, and Violence Perpetrated by their Male Intimate Partners? *Violence Against Women* 2016 Apr 26. pii: 1077801216640381. [Epub ahead of print] PMID: 27118689.

Parker EM, Gielen AC, Castillo R, **Webster D**, Glass N. Intimate partner violence and patterns of safety strategy use among women seeking temporary protective orders: a latent class analysis. *Violence Against Women* 2016 Mar 6. pii: 1077801216631436. [Epub ahead of print] PMID: 26951307.

Messing JT, Campbell J, **Webster DW**, Brown S, Patchell B, Wilson JS. The Oklahoma lethality assessment study: A quasi-experimental evaluation of the Lethality Assessment Program. *Social Service Review* 2015; 89: 499-530. DOI: 10.1086/683194.

Webster DW, Cerdá M, Wintemute GJ, Cook PJ. Epidemiologic evidence to guide the understanding and prevention of gun violence. *Epidemiologic Reviews* 2016; 38(1):1-4. doi: 10.1093/epirev/mxv018. Epub 2016 Feb 10. PMID: 26905892.

Milam AJ, Furr-Holden CD, Leaf P, **Webster D**. Managing Conflicts in Urban Communities: Youth Attitudes Regarding Gun Violence. *J Interpersonal Violence* 2016; Mar 27. pii: 0886260516639584. [Epub ahead of print] PMID: 27021734.

Bushman BJ, Newman K, Calvert SL, Downey G, Drezde M, Gottfredson M, Jablonski NG, Masten AS, Morrill C, Neil DB, Romer D, **Webster DW**. Youth violence: what we know and what we need to know. *American Psychologist* 2016;71:17-39. doi: 10.1037/a0039687.

Wintemute GJ, Frattaroli S, Wright MA, Claire BE, Vittes KA, **Webster DW**. Firearms and the incidence of arrest among respondents to domestic violence restraining orders. *Injury Epidemiol.* 2015;2(1):14. Epub 2015 Jun 23. PMID: 27747746

Bandara SN, Huskamp HA, Riedel LE, McGinty EE, **Webster D**, Toone RE, Barry CL. Leveraging the Affordable Care Act to enroll justice-involved populations in Medicaid: an inventory of state and local efforts. *Health Affairs* 2015;34:2044-51. doi: 10.1377/hlthaff.2015.0668. PMID: 26643624.

Crifasi CK, Pollack K, **Webster DW**. The influence of state-level policy changes on the risk environment for law enforcement officers. *Injury Prevention* 2015 Dec 30. pii: injuryprev-2015-041825. doi: 10.1136/injuryprev-2015-041825. [Epub ahead of print] PMID: 26718550.

Kennedy-Hendricks A, Richey M, McGinty EE, Stuart EA, Barry CL, **Webster DW**. Opioid Overdose Deaths and Florida's Crackdown on Pain Clinics. *Am J Public Health* 2015 Dec 21:e1-e8. [Epub ahead of print] PMID: 26691121.

Rutkow L, Chang HY, Daubresse M, **Webster DW**, Stuart EA, Alexander GC. Effect of Florida's prescription drug monitoring program and pill mill laws on opioid prescribing and use. *JAMA Internal Med* 2015; online August 17, 2015. doi:10.1001/jamainternmed.2015.3931.

Crifasi CK, Meyers JS, Vernick JS, **Webster DW**. Effects of changes in permit-to-purchase handgun laws in Connecticut and Missouri on suicide rates. *Preventive Med.* Jul 23, 2015. pii: S0091-7435(15)00229-7. doi: 10.1016/j.ypmed.2015.07.013. [Epub ahead of print] PMID: 26212633.

McGinty EE, Sell TK, Wolfson JA, **Webster DW**. Political communication about firearm policy in the United States: Competing news media messages about background check proposals in the year following the Newtown shooting. *J Health Politics, Policy, and Law*, 2015 Nov 13. pii: 3445592. [Epub ahead of print] PMID: 26567381.

Barry CL, Kennedy Hendricks A, Gollust SE, Niederdeppe J, Bachhuber MA, **Webster D**, McGinty EE. Understanding Americans' Views on Opioid Pain Reliever Abuse. *Addiction*. 2015 Jul 25. doi: 10.1111/add.13077. [Epub ahead of print] PMID: 26212522

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Webster DW. Suicide in the subway: case consultation: suicide and mass transit: commentary. *Journal of Suicide and Life-Threatening Behavior* 1991;21:209-212.

Books and Book Chapters

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Webster DW, Vernick JS, Eds. *Updated Evidence and Policy Developments on Reducing Gun Violence in America*. Baltimore, MD: Johns Hopkins University Press, 2014.

Webster DW, Vernick JS, Eds. *Reducing Gun Violence in America: Informing Policy with Evidence and Analysis*. Baltimore, MD: Johns Hopkins University Press, 2013.

Chapters contributed to in *Reducing Gun Violence in America: Informing Policy with Evidence and Analysis*. Baltimore, MD: Johns Hopkins University Press, 2013:

Webster DW, Vernick JS, McGinty EE, Alcorn T. "Preventing the Diversion of Guns to Criminals through Effective Firearm Sales Laws," pp. 109-122.

Webster DW, Vernick JS. "Spurring Responsible Firearms Sales Practices through Litigation: The Impact of New York City's Lawsuits Against Gun Dealers on Interstate Gun Trafficking," p. 123-32.

Vittes KA, **Webster DW**, Vernick JS. "Reconsidering the Adequacy of Current Conditions on Legal Firearm Ownership," pp. 65-76.

McGinty EE, **Webster DW**, Vernick JS, Barry CL. "Public Opinion on Proposals to Strengthen U.S. Gun Laws: Findings from a 2013 Survey," pp. 239-257.

Vernick JS, **Webster DW**, Vittes KA. "Law and Policy Approaches to Keeping Guns from High Risk People" in Culhane J. ed. *Reconsidering Law and Policy Debates: A Public Health Perspective*. New York: Cambridge University Press, 2011.

Vernick JS, **Webster DW**. Amicus Brief to U.S. Supreme Court regarding District of Columbia vs. Heller for the petitioner. Written on behalf of American Public Health Assoc., American College of Preventive Medicine, American Trauma Society, and the American Assoc. of Suicidology, Jan. 2008.

Webster DW. Child Access Prevention (CAP) Laws. In Gregg Lee Carter (Ed.) Entry in *Encyclopedia of Guns in American Society*. Santa Barbara, CA: ABC-CLIO, 2003.

Reports

Webster DW, Buggs SAL, Crifasi CK. Estimating the Effects of Law Enforcement and Public Health Interventions to Reduce Gun Violence in Baltimore. Johns Hopkins Center for Gun Policy and Research, Johns Hopkins Bloomberg School of Public Health, January 2018.

Webster DW, Crifasi CK, Vernick JS, McCourt A. Concealed Carry of Firearms: Facts vs. Fiction. Johns Hopkins Center for Gun Policy and Research, November 2017.

Webster DW, Donohue JJ III, Klarevas L, Crifasi CK, Vernick JS, Jernigan D, Wilcox HC, Johnson SB, Greenberg S, McGinty EE. Firearms on College Campuses: Research Evidence and Policy Implications. Johns Hopkins Center for Gun Policy and Research, Johns Hopkins University, October 15, 2016.

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American Psychological Association Panel of Experts Report – (alphabetical listing of contributors) Cornell D, Evans AC Jr., Guerra NG, Kinscherff R, Mankowski E, Randazzo MR, Scrivner E, Sorenson SB, Tynan WD, **Webster DW**. *Gun Violence: Prediction, Prevention and Policy*. American Psychological Association, Washington, DC, December 2013.

Consortium for Risk-Based Firearm Policy (**DW Webster** contributing member). *Guns, Public Health, and Mental Illness: An Evidence-Based Approach to State Policy*. December 2013.

Consortium for Risk-Based Firearm Policy (**DW Webster** contributing member). *Guns, Public Health, and Mental Illness: An Evidence-Based Approach to Federal Policy*. December 2013.

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Webster DW. Whitehill JM, Vernick JS, Parker E. *Evaluation of Baltimore's Safe Streets Program: Effects on Attitudes, Participants' Experiences, and Gun Violence*. Johns Hopkins Center for the Prevention of Youth Violence, January 2012.

Webster DW, Illangasekare SL. Best Practices for the Prevention Youth Homicide and Serious Violence. Johns Hopkins Urban Health Institute, October 2010.

Webster DW, Vernick JS, Mendel J. Interim Evaluation of Baltimore's *Safe Streets Program*. Johns Hopkins Center for the Prevention of Youth Violence, Jan. 2009.

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Webster DW. Interventions to reduce deaths and injuries associated with youth violence. White paper commissioned by the Robert Wood Johnson Foundation. May 2006.

Webster DW. Preventing intimate partner violence. White paper commissioned by the Robert Wood Johnson Foundation. June 2006.

Webster DW, Vernick JS, Teret SP. How Cities Can Reduce Illegal Guns and Gun Violence. Johns Hopkins Center for Gun Policy and Research, April 2006. Updated January 2008.

Campbell JC, **Webster DW**, O'Sullivan C, Roehl J, Mahoney P, White M, Guertin K. Intimate Violence Risk Assessment Validation Study. Report submitted to the National Institute of Justice, September, 2004. 2000WTVX0011.

Webster DW, Kim A. Evaluation of the Maryland Gun Violence Act of 1996: Effects on the Illicit Gun Market. Prepared for the U.S. Bureau of Alcohol, Tobacco, and Firearms, September 2003.

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CURRICULUM VITAE

Daniel W. Webster, Sc.D., M.P.H.

PART II

TEACHING

Classroom Instruction

Instructor: Understanding and Preventing Violence, 1993- present.
Graduate Seminar in Injury Research and Policy, 2005 – present.
Graduate Seminar in Health and Public Policy, 2012 – 2014.

Co-Instructor: Research and Evaluation Methods for Health Policy, 2008 – 2010.

Lead Instructor: Research and Evaluation Methods for Health Policy, 2011-2015.

Lecturer in these JHU courses: Epidemiology and Evidence-Based Policy
Public Health Policy
Health Policy I: Social & Economic Determinants of Health
Proposal Writing (Health Policy & Management)
Introduction to Urban Health
Suicide as a Public Health Problem
Adolescence and Adolescent Health
Issues in Injury and Violence Prevention
Methodological Issues in Injury and Violence
Applications in Program Monitoring and Evaluation
Alcohol, Society, and Health
Baltimore and “The Wire”: A Focus on Major Urban Issues
Community Health Practicum

Advising and Thesis Committees

Primary advisor to: Kim Ammann Howard, PhD, 1997
Jennifer Manganello, PhD, 1999-2003
Allegra Kim, PhD 2001 – 2006
April Zeoli, PhD, 2002 - 2007
Elizabeth Saylor, PhD candidate, 2003 - 2007
Jennifer Mendel Whitehill, PhD, 2006 – 2011
Jillian Fry, PhD, 2007 – 2012
James Saltzman, MPH, 2007-2008
Gayle Nelson, MPH, 2007-2009
Summer Venable, MPH, 2008-2010
Jeane Garcia Davis, MPH, 2008-2011
Donald Chalfin, MPH, 2010 – 2014
Dara Johnson, MPH, 2011 – 2012
Janis Sethness, MPH, 2011 – 2012
Cassandra Kercher, PhD, 2011-2014
Shani Buggs, PhD, 2013 –
Christine McKenna, MPH, 2013-2014
Alexander McCourt, PhD, 2014 -

Co-advisor to: Leonardo Goe (MHS Health Policy), 1997-98
 Rachel Garfield (MHS Health Policy), 1998-
 Emma (Beth) McGinty, PhD, 2010-2013

Thesis committees: Kathleen Roche, PhD in MCH, 1998
 Shannon Frattaroli, PhD in HPM, 1998
 Li-Hui Chen, PhD in HPM, 1999
 Marsha Rosenberg, PhD in Mental Hygiene, 2001
 Lisa Hepburn, PhD in HPM, 2001
 Swapnil P. Maniar, PhD in PFHS, 2005
 Maria Bulzacchelli, PhD in HPM, 2006
 April Zeoli, PhD in HPM, 2007
 Anne Outwater, PhD in Nursing, 2007
 Donna Ansara, PhD in PFHS, 2008
 Vanessa Kuhn, PhD in HPM, 2010
 Susan Ganbarpour, DrPH, 2011
 Mahua Mandel, PhD, 2012
 Lareina La Flair, PhD, 2012
 Gregory Tung, PhD, 2012
 Michael Kim, PhD, 2013
 Elizabeth Parker, PhD, 2013
 Nicole Lunardi, MSPH, 2014

Preliminary oral exam committees: Shannon Frattaroli, Marguerite Roe, Li-Hui Chen, Mary Beth Skupien, Monique Shepard, Beth Hooten, Farfifteh Duffy, Mary Garza, Lisa Hepburn, Marc Starnes, Jennifer Manganello, Allegra Kim, Christina Pallitto, Swapnil Maniar, Christine Koth, Maria Bulzacchelli, Margaret Haynes, Frank Franklin, Donna Ansara, Vanessa Kuhn, Susan Ghanbarpour, Greg Tung, Adam, Milam, Michael Kim, Beth McGinty, Erin Pearson.

Post-Doctoral Mentoring Lorraine Freed, MD, MPH, RWJ Clinical Scholar 1996-98
 Shannon Frattaroli, Kellogg Community Health Scholar, 1999-2000
 Barry Solomon, MD, Pediatric Fellow, 1999-2002
 Erica Sutton, MD, NIMH Violence Research Fellow, 2003-2005
 Lareina LaFlair, NIDA Drug Dependency Epidemiology, 2012-2013

Program Management / Training Program Involvement

Program Head, PhD program in Health and Public Policy, 2006–2007; 2012 -2014.

Faculty Director, Certificate Program in Injury Control, 1999- 2012.

Executive Committee and Core Faculty, Interdisciplinary Research Training Program on Violence Research (pre- and post-doctoral training program funded by NICHD), 2008-2015.

Executive Committee and Core Faculty, Interdisciplinary Research Training Program on Violence (pre- and post-doctoral training program funded by NIMH), 1999-2008.

Core Faculty, Drug Dependency Epidemiology Program (pre- and post-doctoral training program funded by NIDA), 2011-present.

Resource Faculty, Alcohol, Injury and Violence Training Program (pre-doctoral training program funded by NIAAA), 2001-2007.

ACADEMIC COMMITTEES

Appointments and Promotions Committee, School of Public Health, 2012 – 2015.

Conflict of Interest Committee, School of Public Health, 2011 – 2012

Academic Policy and Admissions Committee, HPM, 2006 – 2007, 2012 – 2014

Faculty Development Committee, HPM, 2010 - present

Qualifying Exam Committee, HPM, 1998- 1999, 2001 – 2008, Chair 2004 – 2008

HPM Doctoral Admissions Committee, 2006 – 2007.

Affirmative Action Committee, School, 2005 – 2010.

6 Ad Hoc Committees for Appointments and Promotions, 2006 – present.

Search Committee, Leon Robertson Chair in Injury Control, 2005 – 2006.

Academic Policy and Admissions Committee, HPM, 1997- 1999

Ad-Hoc Committee on Statistics Training, HPM, 1997-1998

Research Policy Committee, HPM, 1995-97

RESEARCH GRANT PARTICIPATION

Active Support

Title: Johns Hopkins-Baltimore Collaborative for Violence Reduction

Dates: 1/1/16 – 9/30/18

Principal Investigator: Daniel W. Webster

Sponsoring Agency: The Abell Foundation and The Annie E. Casey Foundation

Funding Level: \$875,000

Effort: 30%

Main Objectives: Assess police efforts to reduce violent crime and enhance training to promote more effective policing.

Title: Study of Baltimore's Underground Gun Market

Dates: 7/1/15 – 6/30/17

Principal Investigator: Daniel W. Webster

Sponsoring Agency: Everytown for Gun Safety

Funding Level: \$240,245

Effort: 15%

Main Objectives: Collect and analyze data from surveys of offenders, crime gun trace data, and gun-related arrests to describe Baltimore's underground gun market and assess evidence that 2013 state gun laws affected the diversion of guns to criminals.

Title: Effects of Universal Background Check Laws for Handgun Sales in Maryland and Pennsylvania
Dates: 8/1/15 – 7/31/18
Principal Investigator: Daniel W. Webster
Sponsoring Agency: The Joyce Foundation
Funding Level: \$357,000
Effort: 18%
Main Objectives: Describe the implementation and enforcement of universal background check laws for handgun purchases in Maryland and Pennsylvania and estimate the effects of the laws and enforcement practices on gun violence.

Title: Estimating Effects of Gun Policies on Intimate Partner Homicides
Dates: 8/1/15 – 6/30/17
Principal Investigator: Daniel W. Webster, subcontract to Michigan State University
Sponsoring Agency: The Joyce Foundation
Funding Level: \$267,276
Effort: 10%
Main Objectives: To estimate the impact of firearm sales laws on intimate partner homicides and examine factors relevant to successful enforcement of those laws.

Title: Promoting Evidence-based Policies to Reduce Domestic Violence Involving Guns
Dates: 7/1/15 – 6/30/16
Principal Investigator: Daniel W. Webster
Sponsoring Agency: Norman Raab Foundation
Funding Level: \$25,000
Effort: 2%

Title: Analysis of the Strength of Legal Firearms Restrictions for Perpetrators of Domestic Violence and their Impact on Intimate Partner Homicide
Dates: 8/1/15 – 1/31/18
Principal Investigator: Daniel W. Webster
Sponsoring Agency: The Joyce Foundation
Funding Level: \$176,389
Effort: 10%
Main Objectives: Describe the implementation and enforcement of domestic violence related firearm laws and their impact on intimate partner homicides.

Title: Baltimore Homicide Review Commission
Dates: 9/1/14 – 12/31/15
Principal Investigator: Daniel W. Webster
Sponsoring Agency: Baltimore City Mayor's Office
Funding Level: \$135,000
Effort: 15%
Main Objectives: Conduct in-depth reviews of homicides in three police districts in Baltimore to identify determinants of lethal violence and develop recommendations for policies, procedures, and programs to prevent homicides.

Title: Study of Baltimore's Underground Gun Market
Dates: 7/1/14 – 6/30/15
Principal Investigator: Daniel W. Webster
Sponsoring Agency: The Norman Raab Foundation
Funding Level: \$50,000
Effort: 5%
Main Objectives: Gather data about how criminals access firearms, how they connect with suppliers, what barriers they face, and their perceptions of gun laws.

Title: Effects of Drug and Gun Law Enforcement on Violence in Baltimore
Dates: 1/1/14 – 12/31/15
Principal Investigator: Daniel W. Webster
Sponsoring Agency: The Abell Foundation
Funding Level: \$144,918
Effort: 15%
Main Objectives: Estimate the effects of law enforcement activities directed at drug and gun law violations on violent crime in Baltimore from 1986 through 2012.

Title: Gun Owners Perspectives on Safe Gun Ownership and Sales Practices
Dates: 10/01/2013 – 03/31/16
Principal Investigator: Daniel W. Webster
Sponsoring Agency: Harold B. Simmons Foundation
Funding Level: \$411,421
Effort: 20%
Main Objectives: Study gun owners' attitudes relevant to safe firearm sales and storage.

Title: Johns Hopkins Center for the Prevention of Youth Violence
Dates: 9/15/11 – 9/14/16
Principal Investigator: Philip Leaf
Sponsoring Agency: Centers for Disease Control and Prevention
Funding Level: \$6 million
Main Objectives: Develop, implement, and evaluate a comprehensive community intervention to prevent youth violence in the Park Heights neighborhood of Baltimore.
Effort: 20% to 25%

Prior Support

Title: Prescription Opioid Addiction Research Study
Dates: 09/01/2012 – 08/31/2014
Principal Investigator: Colleen L. Barry
Sponsoring Agency: AIG
Funding Level: \$430,655
Main Objectives: To assess of the growing problem of prescription opioid addiction, and to identify promising policy and clinical approaches to address the problem.
Effort: 10%

Title: National Gun Violence Research Center - subcontract
Dates: 05/01/13 – 05/31/14
Principal Investigator: Daniel W. Webster

Sponsoring Agency: Police Executive Research Forum
Funding Level: \$41,762
Effort: 20%
Main Objectives: Assist PERF with designing and conducting studies of innovative policing strategies to combat gun violence.

Title: Evaluation of the Effects of Permit to Purchase Handgun Laws
Dates: 9/1/12 - 8/31/14
Principal Investigator: Daniel W. Webster
Sponsoring Agency: The Joyce Foundation
Funding Level: \$222,242
Main Objectives: To evaluate the effects of changes in permit to purchase handgun laws in Connecticut and Missouri on homicides and the diversion of guns to criminals.
Effort: 25%

Title: Gun Violence Reduction Program
Dates: 1/01/11 – 12/31/13
Principal Investigator: Daniel W. Webster
Sponsoring Agency: Bloomberg Philanthropies
Funding Level: \$500,000
Main Objectives: Conduct research, policy analysis, and technical assistance to inform efforts to reduce the availability of illegal guns and gun violence.
Effort: 5% to 40%

Title: Evaluation of Baltimore Policing Strategies to Reduce Gun Violence
Dates: 10/1/2010 – 3/31/2012.
Principal Investigator: Daniel W. Webster
Sponsoring Agency: U.S. Dept. of Justice, Bureau of Justice Assistance
Funding Level: \$60,000
Main Objectives: Develop unbiased estimates of the impact of 3 strategies being implemented by Baltimore police to reduce violence.
Effort: 15%

Title: Impact of Safe Streets' Outreach Workers on the Lives of Their Clients
Dates: 12/1/09 – 6/30/10
Principal Investigator: Daniel W. Webster
Sponsoring Agency: Baltimore City Health Department
Funding Level: \$72,000
Main Objectives: Measure the impact of the Safe Streets program on program participants and analyze of the relationships between program activities and gun violence.
Effort: 25%

Title: Effects of the Lethality Assessment Program on Intimate Partner Violence
Dates: 3/15/10 – 3/14/12
Principal Investigator: Daniel Webster
Sponsoring Agency: Centers for Disease Control and Prevention (through Center grant to JHU)
Funding Level: \$388,282
Main Objectives: Estimate the effects of the Maryland Lethality Assessment program on

intimate partner homicide and repeat intimate partner violence.

Effort: 20%

Title: Gun Violence Reduction Program
Dates: 1/01/08 – 12/31/10
Principal Investigator: Daniel W. Webster
Sponsoring Agency: Anonymous donor
Funding Level: \$500,000

Main Objectives: Conduct research, policy analysis, and technical assistance to inform efforts to reduce the availability of illegal guns and gun violence.
Effort: 25%

Title: Analyzing and Developing Policies to Limit Firearm Access by High-Risk People
Dates: 5/1/09 – 4/30/11
Principal Investigator: Daniel W. Webster
Sponsoring Agency: The Joyce Foundation
Funding Level: \$179,971
Main Objectives: Research and describe state laws pertaining the potential public safety gains for expanding current prohibition categories for firearm purchase and possession.

Title: Data for Combating Illegal Guns
Dates: 1/01/08 – 12/31/08
Principal Investigator: Daniel W. Webster
Sponsoring Agency: Maryland Governor's Office for Crime Control and Prevention
Funding Level: \$75,419
Main Objectives: Assist Baltimore and Maryland State Police to collect and analyze data on crime guns and illegal gun trafficking.

Title: Analyzing & Assisting Innovative City-Level Efforts to Prevent Gun Violence
Dates: 5/1/07 – 4/30/09
Principal Investigator: Daniel W. Webster
Sponsoring Agency: The Joyce Foundation
Funding Level: \$175,000
Main Objectives: Analyze data on illegal gun trafficking and provide consultation to enhance data to inform efforts to stem gun trafficking in Milwaukee. Case study of Chicago Police Department's efforts to thwart gun trafficking.

Title: Evaluation of the California Firearms Domestic Violence Intervention Project
Dates: 1/15/07 – 1/14/10
Principal Investigator: Garen Wintemute (UC Davis) and Shannon Frattaroli (JHBSPH)
Sponsoring Agency: California Department of Justice
Funding Level: \$31,481 subcontract from UC Davis for first year
Main Objectives: Evaluate a program in 2 California counties to enhance implementation of state laws prohibiting certain domestic violence offenders from possessing firearms.
Effort: 10%

Title: Baseline Data for Evaluating a Community Initiative to Reduce Youth Homicides

Dates 3/01/07 – 2/28/09

Principal Investigator: Daniel W. Webster

Sponsoring Agency: Baltimore City Health Department

Funding Level: \$75,122

Main Objectives: Collect and analyze baseline data on violent crime and youths' attitudes relevant to gun violence in intervention and comparison neighborhoods.

Effort: 6%

Title: Evaluation of a community gun violence prevention initiative in Baltimore.

Dates: 9/1/05 – 8/31/10

Principal Investigator: Daniel W. Webster

Sponsoring Agency: Centers for Disease Control and Prevention

Funding Level: \$745,352

Main Objectives: Estimate the impact of the initiative on youth gun violence victimization and perpetration and attitudes and behaviors of high risk youth.

Effort: 25%-30%

Title: Effects of a Formal Danger Assessment and Risk Communication Intervention on Actions Taken to Reduce Risks of Intimate Partner Violence

Dates: 9/1/04 – 8/31/09

Principal Investigator: Daniel W. Webster

Sponsoring Agency: Centers for Disease Control and Prevention

Funding Level: \$485,000

Main Objectives: Determine whether a formal, quantitative assessment of danger, and a standard protocol for communicating the assessed risk of future partner violence and scientific support for protection strategies is more effective than current procedures in motivating protective actions and lowers risk for future violence.

Effort: 20%-25%

Title: Reducing Illegal Gun Trafficking Through Research and Technical Assistance

Dates: 5/1/05 – 4/30/08

Principal Investigator: Daniel W. Webster

Sponsoring Agency: The Joyce Foundation

Funding Level: \$181,117

Main Objective: Disseminate research findings to law enforcement agencies, advocates, and the media on policies shown to reduce illegal gun trafficking.

Effort: 25%-30%

Title: Effects of Police Stings of Gun Dealers on the Illegal Gun Market

Dates: 11/1/03 - 10/31/04

Principal Investigator: Daniel W. Webster

Sponsoring Agency: The Overbrook Foundation

Funding Level: \$37,000

Main Objectives: Assess the impact of police stings of 12 gun dealers suspected of making illegal gun sales in Chicago on the flow of new guns into the illicit gun market.

Effort: 20%

Title: Evaluating and Developing Policies to Regulate Licensed Gun Dealers
Dates: 4/1/02 - 3/31/04
Principal Investigator: Daniel W. Webster
Sponsoring Agency: The John D. and Catherine T. MacArthur Foundation
Funding Level: \$260,000
Main Objectives: 1) Document state policies and practices for regulation and oversight of licensed gun dealers; 2) Assess effects of those measures on gun trafficking; and 3) Recommend strategies for deterring diversions of guns to criminals.
Effort: 35%

Title: Working with Health Commissioners to Reduce Gun Violence
Dates: 7/01/03 - 6/30/04
Principal Investigator: Jon S. Vernick
Sponsoring Agency: Richard and Rhoda Goldman Fund
Funding Level: \$100,000
Main Objective: Identify and provide technical assistance to city or county health commissioners in order to use public health powers to shut down corrupt gun dealers who endanger the public's health.
Effort: 15%

Title: Separating Kids from Guns Program
Dates: 10/01/01 - 9/30/03
Principal Investigator: Shannon Frattaroli
Co-PI: Daniel W. Webster
Sponsoring Agency: The David and Lucille Packard Foundation
Funding Level: \$300,000
Main Objective: Conduct research, perform policy analysis, disseminate information relevant to protecting children and adolescents from unsupervised access to guns.
Effort: 25%

Title: Johns Hopkins Center for Gun Policy and Research
Dates: 01/01/99 - 4/30/04
Sponsoring Agency: The Joyce Foundation
Principal Investigator: Stephen P. Teret (1995-2001), Jon S. Vernick (2001-present)
Co-Prin. Invest.: Daniel W. Webster (2001-present)
Funding Level: 2001-2003: \$600,000
Main Objective: Develop and analyze policies to reduce firearm injuries.
Responsibilities: Co-direct Center, initiate and conduct research and analysis relevant to gun policy; develop and analyze gun policy surveys; assist groups working to reduce gun violence; serve as resource to media and policymakers.
Effort: 15% (05/01/03 - 4/30/04)
35% (05/01/01 - 4/30/03)
25% (01/01/00 - 4/30/01)
35% (01/01/96 - 12/31/99)
20% (01/01/95 - 12/31/96)

Title: Effects of Minimum Age Restrictions on Handgun Purchase and Possession – Center for the Prevention of Youth Violence

Dates: 10/01/00 - 9/30/05

Principal Investigator: Daniel W. Webster

Sponsoring Agency: Centers for Disease Control and Prevention

Funding Level: \$306,695

Main Objective: Estimate the effects of minimum age restrictions on handgun purchases and possession on youth homicide offending and suicides

Title: Evaluation of Instruments to Assess Risk for Intimate Partner Violence

Dates: 08/01/00 - 03/31/04

Principal Investigator: Jacquelyn C. Campbell

Sponsoring Agency: National Institute of Justice

Funding Level: \$619,792

Main Objective: Determine the sensitivity, specificity, and predictive value of four instruments designed to assess future risk for violent victimization by an intimate partner.

Effort: 20%

Title: The Center for Injury Research and Policy:

Dates: 1987-2005

Sponsoring Agency: Centers for Disease Control and Prevention

Principal Investigator: Ellen MacKenzie

Funding Level: 1999-2003: \$750,000 per year.

Main Objective: One of the eight regional injury control research centers.

Responsibilities: Evaluate state-level gun policies, direct study of risk factors for serious injuries from intimate partner assaults, develop research proposals, serve as resource to students, media, practitioners, and policy makers.

Effort: 10% (09/03/03 - 8/31/04) 20% (04/01/94 - 08/31/94)
 10% (09/01/00 - 8/31/01) 50% (07/01/92 - 03/31/94)
 20% (09/01/99 - 8/31/00) 100% (04/01/92 - 06/30/93)
 25% (09/01/94 - 08/31/98) 10% (09/01/98 - 08/31/99)

Title: Developing and Analyzing Data for Effective Gun Law Enforcement

Dates: 03/01/01 - 02/28/02

Principal Investigator: Daniel W. Webster

Sponsoring Agency: Governor's Office of Crime Control and Prevention

Funding Level: \$102,911

Main Objective: Develop databases for information about the sources of crime guns and the prosecution of gun crimes

Effort: 35%

Title: Developing a Dataset of State Gun Laws

Dates: 12/01/00 - 11/30/01

Principal Investigator: Jon S. Vernick

Sponsoring Agency: Annie E. Casey Foundation

Funding Level: \$45,000

Main Objective: Determine the presence and effective dates of specific types of gun laws in each of the 50 U.S. states and the District of Columbia. Create a dataset with

Effort: this information and provide the information to interested researchers.
10%

Title: Effects of Personalized Guns in Maryland
Dates 9/1/99 - 8/31/00
Sponsoring Agency: The Abell Foundation
Funding Level: \$40,533
Principal Investigator: Stephen Teret
Main Objective: Assess likely effects of a law to require personalized guns in Maryland
Effort: 10%

Title: Risk Factors for Homicide in Violent Intimate Relationships
Dates: 09/01/96 - 02/28/00
Sponsoring Agency: NIDA, NIMH, CDC, NIJ, NIA
Principal Investigator: Jacquelyn Campbell
Funding Level: \$1,267,744
Main Objective: Determine risk factors for homicide or attempted homicide among women involved in violent intimate relationships and develop predictive screening devices for clinicians, shelter workers, and the courts.
Effort: 10% (09/01/99 - 02/28/00)
25% (09/01/98 - 08/31/99)
10% (09/01/97 - 08/31/98)
15% (09/01/96 - 08/31/97)

Title: Preventing Firearm Suicide and Unintentional Deaths Through Safer Gun Design
Dates: 01/01/00 - 12/31/00
Principal Investigator: Jon S. Vernick
Sponsoring Agency: Funders' Collaborative for Gun Violence Prevention
Funding Level: \$176,755
Main Objective: Evaluate potential benefits of safer gun designs
Effort: 10%

Title: Public Attitudes About New Law Enforcement Technologies
Dates: 06/01/97 – 05/31/99
Sponsoring Agency: National Institute of Justice
Principal Investigator: Daniel W. Webster
Funding Level: \$266,625
Main Objectives: Assess public attitudes relevant to law enforcement strategies to detect concealed weapons in high-crime areas including the use of new technology, concerns about safety, privacy, and fairness in the way that law enforcement officials apply new technology. Qualitative study of residents of a high-crime neighborhood in Baltimore and a national phone survey of urban residents.

Title: Evaluation of the California Violence Prevention Initiative
Dates: 07/01/93 - 04/15/96
Sponsoring Agency: The California Wellness Foundation

Principal Investigator: Stephen P. Teret
Co-Prin. Investigator: Daniel W. Webster
Funding Level: \$3.1 million
Main Objectives: Conduct process and outcome evaluation of a statewide violence prevention initiative.
Effort: 50%

Title: Evaluation of Violence Prevention Public Education Campaign
Dates: 04/01/94 - 03/31/95
Sponsoring Agency: The California Wellness Foundation
Principal Investigator: Daniel W. Webster
Funding Level: \$40,000
Main Objectives: The describe all facets of the campaign and the political and social context in which the campaign is conducted and evaluate the effects of the campaign on public opinion, opinion leaders, the media, and policy makers.
Effort: 20%

Title: Planning "The Consortium on Gun Policy and Information"
Dates: 04/01/94 - 10/31/94
Sponsoring Agency: The Joyce Foundation
Principal Investigator: Stephen P. Teret
Funding Level: \$40,000
Main Objectives: To assess the need for a "Consortium on Gun Policy and Information" that would provide factual information on firearms and the public's health to various consumers. Examine the feasibility of creating a Consortium, explore the policy role that such an organization might fulfill, and describe the methods by which accurate information could be disseminated.
Effort: 10%

PRESENTATIONS

Scientific Meetings

Webster DW. Research and public safety collaborations focused on reducing gun violence in Baltimore. Presented at the Annual meeting of the American Society of Criminology, New Orleans, November 2016.

Webster DW. What have we learned about the impact of states' gun policies. Plenary session presentation at the annual meeting of the American Public Health Association, Denver, Nov. 2016.

Webster DW, Crifasi CK, Meyers JS, Vernick JS. Effects of changes in permit-to-purchase handgun laws on suicide rates. Presented at the Annual Meeting of the American College of Epidemiology, Atlanta, GA, September 29, 2015.

Webster DW, Meyers JS, Buggs S. Access to firearms among youth in the United States: Patterns, consequences, and prevention strategies. Presented at the Institute of Medicine's Forum on Global Violence Prevention, Workshop on Lethal Means of Violence, Washington, DC, December 18, 2014.

Webster DW. State of the science and need for additional research to prevent gun violence in America. Presentation at the Martha May Elliott Forum at the American Public Health Association Annual Meetings, New Orleans, November 2014.

Webster DW. Community Involvement in the Evaluation of Baltimore's Safe Streets Program to Reduce Youth Violence. Presented at the annual meetings of the Society for Prevention Research, Washington, DC May 29, 2014.

Webster DW. Mental health and means of violence. Presented at Workshop on Violence and Mental Health: Opportunities for Prevention and Early Intervention, Institute of Medicine's Forum on Global Violence Prevention, February 26, 2014.

Webster DW. Effects of Missouri's permit to purchase handgun licensing law on the diversion of firearms to criminals and homicides. Presented at the annual meetings of the American Public Health Association, Boston, November 2013.

Vittes KA, **Webster DW**, Vernick JS. Associations between state gun sales laws and the source of criminals' handguns they used to commit crime. Presented at the annual meetings of the American Public Health Association, Boston, November 2013.

Webster DW. Effects of Baltimore's Safe Streets Program on Gun Violence and Youth Attitudes toward Resolving Conflicts with Guns. Presented at the World Health Summit, Berlin, Germany, October 2013.

Webster DW. Safe Streets Baltimore – program effects on gun violence, youth attitudes, and the lives of program participants. Presented at the meetings of the Society for the Advancement of Violence and Injury Research, Baltimore, June 2013.

Parker EM, Gielen AC, Castillo R, **Webster DW**. Intimate Partner Violence and Patterns of Safety Strategy Use among Women Seeking Temporary Protective Orders: A Latent Class Analysis. Presented at the meetings of the Society for the Advancement of Violence and Injury Research, Baltimore, June 2013.

Webster DW. Priorities for public health efforts to reduce gun violence. Presentation to the Institute of Medicine's Workshop on Priorities for Public Health Research Agenda to Reduce Firearm-Related Violence, Washington, DC, April 2, 2013

Webster DW. State gun laws' effects on the intra- and interstate diversion of guns used by criminals. Presented at the annual meetings of the American Society of Criminology, Washington, DC, November 2011.

Webster DW. Effects of state gun sales laws on the exportation of guns used by criminals. Presented at the annual meetings of the American Public Health Association Meetings, Washington, DC, November 2011.

Webster DW, Mendel JS, Vernick. Evaluating Baltimore's Safe Streets Program's effects on violence. Presented at the annual meetings of the Amer. Public Health Assoc., Denver, Nov. 2010.

Webster DW, Vernick JS, Mendel JS. Interim evaluation of Baltimore's Safe Streets initiative: Effects on gun violence. Presented at the Annual Meetings of the American Public Health Association, Philadelphia, November 2009.

Webster DW. Impact of danger assessment screening and safety education on abused women's perceived risk of serious re-abuse. Presented at the Annual Meetings of the American Public Health Association, Philadelphia, November 2009.

Mendel JS, **Webster DW**, Vernick JS. Street outreach to prevent gun violence in Baltimore: An analysis of high-risk conflict mediation. Presented at the Annual Meetings of the American Public Health Association, Philadelphia, November 2009.

Vernick JS, **Webster DW**. An environmental approach to preventing firearm violence: targeting illegal gun trafficking. Annual Meetings of Amer. Public Health Assoc., Philadelphia, Nov. 2009.

Vittes KA, **Webster DW**. Potential effects of expanding firearm prohibitions in the U.S.: analysis of data from a national survey of prisoners. Presented at the Annual Meetings of the American Public Health Association, Philadelphia, November 2009.

Webster DW, Vernick JS, Bulzacchelli MT. Effects of Policies to Promote Firearm Dealer and Owner Accountability on Firearm Trafficking. Presented at the Annual Meeting of the American Public Health Association, Washington, DC, November 2007.

Webster DW. Firearm violence roundtable: Data collection, data quality, and data access. Roundtable discussion led at the Annual Meeting of the American Public Health Association, Washington, DC, November 2007.

Webster DW, Vernick JS. Implementation of a Community Gun Violence Prevention Program: A Focus on Outreach Workers' Efforts. Presented at the Annual Meeting of the American Public Health Association, Washington, DC, November 2007.

Webster DW, Mahoney P, Campbell JC, Ghanbarpou S, Stockman J. Factors associated with seeking a long term protective order and staying away among women seeking temporary protective orders against a male partner. Presented at the Annual Meeting of the American Public Health Association, Washington, DC, November 2007.

Webster DW, Mahoney P, Campbell JC, Ghanbarpou S. Communicating empirically-based information about risks and protection strategies to survivors of intimate partner violence. Presented at the Annual Meeting of the American Public Health Association, Washington, DC, Nov. 2007.

Webster DW, Vernick JS, Bulzacchelli MT. Association Between Regulations and Oversight of Firearm Dealers and Gun Trafficking. Presented at the Annual Meeting of the American Society of Criminology, Atlanta, November 2007.

Campbell JC, O'Sullivan C, Roehl J, **Webster DW**, Mahoney P, White M, Eliacin J, Guertin K. What battered women know and do to protect themselves from abuse: results and methodological challenges from the domestic violence risk assessment validation experiment. Paper presented at the 9th International Family Violence Research Conference, Portsmouth, NH, July 2005.

Webster DW, Vernick JS, Manganello JA, Zeoli AM. Effects of youth-focused firearm laws on youth suicides. Paper presented at the annual meeting of the American Public Health Association, Washington, DC, November 2004.

Vernick JS, **Webster DW**, Pierce MW, Johnson SB, Frattaroli S. Judging the constitutionality of injury interventions using empirical data: The case of concealed weapons detectors. Paper presented at the annual meeting of the American Public Health Association, Washington, DC, November 2004.

Vernick JS, Lewin NL, Beilenson PL, Mair JS, Lindamood MM, Teret SP, **Webster DW**. Using local public health powers as a tool for gun violence prevention: The Baltimore Youth Ammunition Initiative. Paper to be presented at the annual meeting of the American Public Health Association, Washington, DC, November 2004.

Webster DW. Cracking down on corrupt gun dealers in Chicago: Effects on the illicit gun market. Paper presented at the annual meeting of the American Public Health Association, San Francisco, November 2003.

Campbell JC, **Webster DW**, Mahoney P, Rhoel J, O'Sullivan C. Domestic violence risk assessment and history of injury. Presented at the Annual Meeting of the American Public Health Association, San Francisco, November 2003.

Kim A, **Webster DW**. Effects of a one-gun-a-month purchase limit on illicit gun trafficking and availability. Presented at the Annual Meeting of the American Public Health Association, San Francisco, November 2003.

Campbell JC, **Webster DW**, Chouaf K, et al. "If I can't have you, no one can": Further exploration of estrangement increasing risk of intimate partner femicide. Presented at the Annual Meetings of the American Society of Criminology, Chicago, November 2002.

Kim A, **Webster DW**. The effects of the 1996 Maryland Gun Violence Prevention Act on Illicit Gun Markets. Presented at the Annual Meeting of Amer. Public Health Assoc., Philadelphia, Nov. 2002.

Webster DW, Vernick JS, Hepburn L. The association between licensing, registration, and other gun sales laws and the state-of-origin of crime guns. Presented at the National Association for Injury Control Research Centers meeting, Pittsburgh, May 2001.

Webster DW, Vernick JS, Hepburn L. The association between licensing, registration, and other complementary gun sales laws and the state-of-origin of crime guns. Presented at the annual meetings of the American Public Health Association, Boston, November 2000.

Campbell JC, **Webster DW**, et al. Risk factors for intimate partner femicide among women in physically abusive relationships. Presented at the annual meetings of the American Public Health Association, Boston, November 2000.

Webster DW, Vernick JS, Hepburn L. Can comprehensive gun control and enforcement keep guns from being used in crime? Presented at the annual meetings of the American Society of Criminology, Toronto, Ont., November 1999.

Roche K, **Webster DW**, Alexander C, Ensminger M. Neighborhood effects on the association between parenting and youth fighting. Presented at the American Sociological Association Annual Meetings, 1999.

Webster DW. Assessing sources of data on risk factors for intimate partner homicide: Proxy respondent surveys versus police records. Femicide Research Working Meeting, Chapel Hill NC, February 1999.

Webster DW, Campbell JC, Curry MA. Issues of using proxy informants in femicide research. Annual meetings of the American Society of Criminology, Washington DC, November 1998.

McFarlane J, **Webster DW**, Campbell JC, Block CR, Ulrich Y. Femicide with and without suicide by an intimate partner: A comparative analysis. Annual meetings of the American Society of Criminology, Washington DC, November 1998.

Webster DW, Vernick JS, Huang K. The effects of Maryland's law banning Saturday Night Specials on homicides. American Public Health Assoc. Annual Meeting, Washington DC, Nov. 1998. Vernick JS, **Webster DW**, Huang K. Maryland's 1988 law banning Saturday Night Special handguns: Effects on intermediate outcomes. American Public Health Association Annual Meeting, Washington DC, November 1998.

Webster DW. Investigating a sudden increase in the lethality of shootings in Baltimore: A case study. American Public Health Association Annual Meeting, Indianapolis IN, November 1997.

Freed LH, Wilson MHS, Longwell JJ, Carrese J, **Webster DW**. Deterrent to gun carrying among incarcerated adolescent males. Presented at the Annual Meeting of the Robert Wood Johnson Clinical Scholars Meeting, November 1998.

Webster DW, Kaljee L, Vernick JS, Cameron DD. Attitudes about new law enforcement technologies and strategies for detecting concealed weapons in a high-crime urban community. Presented at the National Institute of Justice Annual Research and Evaluation Meetings, Washington DC, July 1998.

Webster DW, Campbell JC. Issues in using case-control methods in homicide research. Annual Meetings of the American Society of Criminology, San Diego CA, November 1997.

Webster DW. Methodological challenges to evaluating the Brady Law. Annual Meetings of the Homicide Research Working Group, Shepherdstown, WV, June 9 1997.

Webster DW. Modifying guns to reduce child and adolescent mortality: A Risk Analysis. American Public Health Association Annual Meeting, New York, November 1996.

Webster DW. School-based efforts to reduce adolescent violence. Presented at Children Harmed and Harmful: Risks and Risk-Taking Among 10-15 Year-Olds, Working Conference. Chicago, September 1994.

Webster DW. Tackling the problem of gun carrying among youth: Behavior change vs. environmental change. Paper presented at the National Conference on Risk-Taking Behaviors Among Children and Adolescents. Arlington, VA, June 1994.

Webster DW. Individual vs. community perspective on the study and prevention of youth weapon carrying. Public Health Service Annual Professional Meetings, Baltimore, MD, April 1994.

Webster DW, Wilson MEH. The role of primary care pediatricians in preventing firearm injuries to children and youth. Johnson & Johnson Pediatric Institute Conference on the Pediatrician's Role in Violence Prevention, Dulles, VA, March 1994.

Webster DW, Gainer PS, Champion, HR. Determinants of weapon carrying within a sample of inner city junior high school students. Paper to be presented at the American Public Health Association Annual Meetings, Washington, DC, November 1992.

Webster DW. Short-term effects of a primary prevention program for youth violence. American Psychiatric Association Annual Meetings, Washington, DC, May 1992.

Webster DW, Sykes L, Champion HR, Gainer PS. The effects of Washington D.C.'s epidemic of gun violence on trauma center admissions and wound profiles. American Public Health Association Annual Meetings, Atlanta, GA, November 1991.

Champion HR, Oschner MG, **Webster DW.** A retrospective review of over 300 abdominal gunshot wounds at an urban Level I trauma center. International Society of Surgery Conference, Stockholm, Sweden, August 1991.

Wilson MEH, **Webster DW**, Duggan AK, Pakula LC. Firearm injury prevention counseling: are pediatricians and parents ready? American College of Physicians Annual Meetings, April 1991.

Webster DW, Wilson MEH, Duggan AK. Parental beliefs and practices concerning firearm injury prevention. American Public Health Association Annual Meetings, New York, October 1990.

Webster DW, Wilson MH, Duggan AK. Determinants of pediatrician firearm injury prevention counseling practices. American Public Health Assoc. Annual Meetings, New York, October 1990.

Webster DW, Wilson MH, Duggan AK. Pediatrician attitudes and practices concerning firearm injury prevention counseling. Amer. Pediatric Soc./Soc. Pediatric Research Meetings, Chicago, 1990.

Waller AE, **Webster DW**, Baker SP. Homicide and suicide among children, United States, 1980-1985. American Public Health Association Annual Meeting, Chicago, October 1989.

Keyl PM, **Webster DW**, Smith GS, Baker SP. The effect of Maryland's seat belt law on fatality risks. SAE Conference on the Evaluation of Trends in Auto Safety, National Highway Traffic Safety Administration, Washington, DC, May 1989.

Invited Presentations / Seminars / Webinars

A Roadmap for Reducing Gun Violence in America. 28th Annual Herbert Lourie Memorial Lecture on Health Policy, Maxwell School of Citizenship and Public Affairs, Syracuse University, Oct. 2016.

Gun Violence in America: How Culture and Politics Shape Our Response. Public Health Models for Reducing Gun Violence. 22nd Annual Rosemary Flanigan Lecture, Center for Practical Bioethics, KU School of Medicine, The University of Kansas, August 2016.

Lessons from Baltimore's Safe Streets Program on Community Efforts to Reduce Gun Violence. National Academies of Science, Engineering, and Medicine Workshop on Community Violence Prevention. Brooklyn, NY, June 16, 2016.

Effects of Extending Background Check Requirements to Firearm Sales by Private Gun Owners. White House meeting for state and local officials on strategies to reduce gun violence. Washington, DC, May 24, 2016.

Priorities for Advancing Research on Gun Violence. American Association for the Advancement of Science Forum on Science and Technology Policy, Washington, DC, April, 2016.

Evidence to Guide Public Health Efforts to Reduce Gun Violence. Keynote presentation at Gun Violence: A Public Health Crisis Symposium, Washington University of St. Louis, April 5, 2016.

Effects of drug law enforcement practices on gun violence in Baltimore, 2003-2015. Presentation at 2016 National High-Intensity Drug Trafficking Areas Conference, Washington, DC, Feb. 18, 2016.

Public health approaches to reducing gun violence in America. Presentation at Moving from Crisis to Action: A Public Health Approach to Reducing Gun Violence, Mother Emanuel A.M.E. Church, Charleston, SC, Dec. 4, 2015.

Evidence on policies to keep guns from high-risk individuals. The Brady Center for Gun Violence Prevention and the American Public Health Association's Summit. Washington, DC, Oct. 27, 2015.

Charting a Course Toward Fewer Gun Deaths in America. National Public Health Week Grand Rounds Lecture, Drexel University, School of Public Health, Philadelphia, April 8, 2015.

Evidence to Guide Gun Violence Prevention in America. National Public Health Week Grand Rounds, University of Delaware, Newark, DE, April 6, 2015

Research on Policies to Keep Firearms from Dangerous People. Forum on Gun Violence Prevention. American Public Health Association and Brady Campaign to Prevent Gun Violence. Washington, DC, March 2, 2015.

Why Collective Efficacy Makes us Safer than "Good Guys with Guns." Q Commons Baltimore. Baltimore. February 26, 2015.

Evidence that State Gun Policies Can Reduce Gun Availability to Criminals and Gun Violence. Gun Violence Prevention Summit for State Legislators, Arlington, VA, December 9, 2014.

Opportunities and Challenges for Prosecutors Combatting Gun Violence in America. Keynote presentation to the first meeting of Prosecutors Against Gun Violence, Atlanta, Oct. 21, 2014.

Evidence-Based Strategies to Reduce Gun Violence in America. Presentation as part of the Distinguished Guest Faculty Seminars, University of Michigan Injury Research Center, Ann Arbor, Oct. 21, 2014.

Evidence-Based Strategies for Reducing Gun-Related Violence and Injuries Among Youth. Grand Rounds Presentation, Department of Pediatrics and Adolescent Medicine, Johns Hopkins University, School of Medicine. Sept. 24, 2014.

America's Path to Fewer Gun Deaths. Presented at TEDMED Conference, Washington, DC, Sept. 10, 2014.

Evidence-Based Policies to Reduce Gun Violence in America. George Mason University, Center for Evidence-Based Crime Policy's 2014 Symposium, June 23, 2014.

Using Research Evidence to Strengthen Maryland's Gun Laws. Mid-Atlantic Public Health Grand Rounds, Johns Hopkins Bloomberg School of Public Health, June 18, 2014.

Evidence to Support Efforts to Reform America's Gun Laws. The Brady Campaign Summit. Washington, DC, November 2013.

A Way Forward for Policies to Reduce Gun Violence in America. Invited to be a William J. Clinton Distinguished Lecturer for the Clinton School of Public Service, University of Arkansas, Little Rock, Sept. 10, 2013.

Public Health Approaches to Reducing Gun Violence. The Group Dynamics Seminar Series, Institute for Social Research, University of Michigan, Ann Arbor, MI, October 7, 2013.

Preventing Intimate Partner Homicides by Keeping Firearms from Perpetrators of Domestic Violence. Summit on Civil Protection Orders, National Council of Juvenile and Family Court Judges, Washington, DC, June 2013.

Data and Informatics needs for gun violence prevention research. Webinar for the Public Health Informatics Working Group for the American Medical Informatics Association. June 2013.

Webinar: Gun Violence: The Healthcare Providers Role in Prevention, National Healthcare Collaborative on Violence and Abuse., June 2013.

Firearm Policy and Gun Violence Prevention. Webinar for California Public Health Grand Rounds, May 2013.

Public Health Interventions to Reduce Gun Violence to Youth. Keynote session, Pediatric Academic Societies Annual Meeting, May 2013.

Priorities for a Public Health Research Agenda to Reduce the Threat of Firearm-Related Violence: Workshop. Institute of Medicine, Washington, DC, April 2013.

Preventing Violence with Policies to Keep Guns from High-Risk People. George Washington University, School of Public Health, Forum – From Dialogue to Action: Preventing Gun Violence, April 5, 2013.

Research to Inform Policies to Keep Guns from High Risk People. The United States General Accountability Office, April 3, 2013.

Policy Priorities for Reducing Youth Gun Violence: A Way Forward. Semi-annual meeting of the Maternal and Child Health Section of the American Public Health Association, February 2013.

Importance of Assessing Threats to Study Validity: Cautions About Applying Questionable Evidence to Policies and Programs to Reduce Violence. Evidence for Violence Prevention Across the Lifespan and Around the World: A Workshop of the Forum on Global Violence Prevention, Institute of Medicine, Washington, DC, January 23-24, 2013.

Preventing Gun Violence to Youth. Keynote presentation, King Holiday Celebration, Martin Luther King, Jr. Center for Non-Violence, New York, NY, January 2013.

Changing the Code of the Street in Baltimore's Most Violent Neighborhoods: Evaluation of a *CeaseFire*-like Intervention. Patricia F. Waller Lecture. University of North Carolina, October 2012.

Reducing Risk for Reassault of Victims of Intimate Partner Violence. Network for Public Health Law's Eastern Region Symposium. University of Maryland Law School, Baltimore, June 26, 2012.

Firearm Seller Accountability Measures and the Diversion of Guns to Criminals. Congressional briefing organized by George Mason University's Center for Evidence Based Crime Policy, Washington, DC, February 2012.

Research with Victims of Intimate Partner Violence: Risks, Benefits, and Safety Strategies. Plenary session, Advancement of Ethical Research Conference, National Harbor, MD, December 2011.

Evaluating Baltimore's Replication of Chicago's *CeaseFire* Program: Effects on Youth Attitudes and Gun Violence. Centers for Disease Control and Prevention, Atlanta, January 7, 2010.

Public Health Approaches to Gun Violence Prevention. Conference on Promoting Community Safety and Preventing Violence: Integrating Lessons from Research and Practice. Ohio State University, Columbus, OH, June 2009.

Keys to States Keeping Guns From Criminals and Reducing Gun Violence. Meeting of State Legislators Against Gun Violence, Gracie Mansion, New York, May 8, 2009.

Effects of Baltimore's Safe Streets Program: A Public Health Approach to Reducing Gun Violence. Trauma Seminar Series, Johns Hopkins Hospital, March 2009.

Effective Strategies for Combating Illegal Guns and Gun Violence. Roundtable on Gun Violence Prevention, International Association of Chiefs of Police, Chicago, IL, November 2008.

Research Supporting the Lethality Assessment Program. Maryland Judicial Conference, Linthicum Heights, MD, June 20, 2008.

Evidence-Based Strategies for Reducing Illegal Guns and Gun Violence. Seminar for the Baltimore

Police Department Command Staff Training, Baltimore, May 22, 2008.

Preventing Gun Violence. Invited seminar for the Baltimore City Circuit Court Judges, April 2008.

How Cities Can Reduce Gun Violence. Mid-Atlantic Regional Meeting, Mayors Against Illegal Guns, March 2007. Strategies to Reduce Illegal Gun Trafficking. Harvard Injury Control Research Center, January 2007.

Expert Panel, Midwest meeting of Mayors Against Illegal Guns, Chicago, October 2006.

Expert Panel for Mayors Against Illegal Guns Summit. New York, April 2006.

Promising Approaches for Violence Prevention. Association of Baltimore Area Grantmakers, Baltimore, March 2006.

Evidence of the Effectiveness of Gun Policies. Graduate Seminar in Injury Research and Policy, Johns Hopkins Bloomberg School of Public Health, February 2004.

Recent Research on Gun Violence Prevention. Seminar at the 2003 Child Advocacy Leadership Institute, Advocates for Children and Youth, Washington, DC, November 2003.

Gun Policy: Understanding the Research and Defending the Data. Seminar at 2002 Child Advocacy Leadership Institute, National Association of Child Advocates, Washington, DC, November 2002.

Preventing Gun Violence Among Youth. Seminar for the University of Maryland Journalism Fellowship in Child and Family Policy, Washington, DC, November 2002.

Opportunities for Preventing Gun Violence in the U.S. Robert W. Leraas Lecture, St. Olaf College, Northfield MN, October 2002.

The Impact of Gun Safe Storage Laws on Firearm Mortality Risks among Youth. National Academy of Sciences, Institute of Medicine Meeting on Youth and Gun Violence. Washington, DC, Sept 2002.

Recent Research on the Effectiveness of Gun Policies. Citizens' Conference to Stop Gun Violence. Arlington, VA, February 2002.

How Criminally-Involved Youth Obtain Their Guns. Citizens' Conference to Stop Gun Violence. Arlington, VA, February 2002.

The Role of Alcohol in Interpersonal Violence. Johns Hopkins University, Center for Injury Research and Policy Seminar, October 2001.

Risk Factors for Near Fatal Intimate Partner Assaults. Johns Hopkins University, Department of Mental Hygiene's Seminar Series on Violence Research, September 2001.

Effects of child access prevention gun laws on unintentional gun deaths to children. Presented at the annual meeting of the Handgun Epidemic Lowering Plan (HELP) Network, Atlanta, April 2001.

Public health models for reducing gun violence. Grand rounds presentation at George Washington University School of Medicine, Washington, DC, April 2000.

Methodological challenges to studying risk factors for intimate partner homicide. Seminar for the Center for Injury Research and Policy, Johns Hopkins School of Public Health, March 1999.

School-based interventions to reduce youth violence: Do our programs fit the problem? Annual conference of Maryland State School Health Council, Ocean City MD, April 1998.

The role of health professionals in the prevention of youth violence. Continuing medical education seminar at Bethesda Memorial Hospital, Boynton Beach, FL, February 1998.

Determinants of youth violence and scientific support for interventions. Best Practices in Adolescent Health Conference, Annapolis MD, May 1996.

Media advocacy and public health: A case study of a campaign to increase support for handgun restrictions. Johns Hopkins University School of Public Health Seminar, April 1995.

The evaluation of the policy program of the California Wellness Foundation's Violence Prevention Initiative, MPH Seminar, November 1995.

The limitations of skill-focused conflict resolution curricula for reducing youth violence. Handgun Epidemic Lowering Plan (HELP) Network Annual Meeting. Chicago, September 1994.

Promising public health approaches to violence prevention. Presentation to the Board of Directors, Physicians for Social Responsibility, Bethesda, MD, March 1994.

The ability of gun laws to reduce deaths and injuries. Presentation to the Maryland State Office of Strategic Drug Enforcement Coordination, Columbia, MD, January 1994.

The limitations of conflict resolution curricula for adolescents. National Symposium on Violence, Safety, and Health in Urban Schools. Sponsored by the Council of Great City Schools, Washington, DC, December 1993.

The role of public health in violence prevention. JHU Seminar sponsored by the Department of Mental Hygiene and The Injury Prevention Center, December 1993.

Research on Strategies to Prevent Youth Violence. Creative Solutions to Problem of Urban Violence. Symposium sponsored by the Baltimore Urban League and the YMCA. Baltimore, April 6, 1993.

Public Health Professionals' Role in Reducing Injuries from Violence. Preventive Medicine in Minority Communities: First or Last Resort? Symposium sponsored by the Student National Medical Association of The Johns Hopkins School of Medicine. Baltimore, MD, April 3, 1993.

Health Professionals' Role in Limiting Children's Access to Firearms. Surgeon General's Invitational Workshop. Keeping Kids Safe: Strategies for Preventing Violence and Injury, Columbia, MD, November 19, 1992.

A Legislative Agenda for Violence Reduction. Consortium of Virginia Urban Municipalities, Williamsburg, VA, July 10, 1992.

Keynote Address: The epidemiology of violence and public health approaches to the problem. 13th Annual Institute of the Virginia Organization of Health Care Social Workers, Richmond, June 1992.

Research Objectives

To study the causes and prevention of interpersonal and self-inflicted violence and associated injuries; to study the effectiveness interventions intended to reduce severe forms of violence; to develop and assess instruments designed to assess the risk for future violence.

Keywords

violence, violence prevention, firearm injuries, gun policy, domestic violence, substance abuse

Community Involvement:

Coach, Bethesda-Chevy Chase Baseball Youth League 2001- 2010.

Served as Co-Chair of Social Justice Committee and as a member of the Board of Trustees at Temple Emanuel, Kensington, MD, 2004- 2007.

Declaration Exhibit 2

EXPERT REPORT OF DANIEL WEBSTER, ScD

I have been retained as an expert by the Maryland Attorney General's Office to provide an opinion on the research evidence relevant to the provision of the Firearm Safety Act of 2013 that requires purchasers of regulated firearms to obtain a Handgun Qualification License, a policy that is generally referred to a Permit to Purchase (PTP) or handgun purchaser licensing law.

RELEVANT CREDENTIALS

I am Professor of Health Policy and Management, Co-Director for Research at the Center for the Prevention of Youth Violence, and Director of the Johns Hopkins Center for Gun Policy and Research at the Johns Hopkins Bloomberg School of Public Health. Additionally, I head the Johns Hopkins-Baltimore Collaborative for Violence Reduction, a technical assistance and applied research support to the Baltimore Police Department and the State's Attorney for Baltimore City.

I began my career in public safety research in 1985 as a Research Associate at the University of Michigan's School of Public Health directing ground-breaking research on the association between alcohol use patterns of parents and their offspring during adulthood as part of longitudinal community health cohort study. I have devoted most of my research since then on studies relevant to gun-related injuries and violence. I have a Master of Public Health degree from the University of Michigan (1985) and a doctorate in Health Policy and Management from the Johns Hopkins School of Public Health (1991). This graduate training included many advanced courses in epidemiology, research methods, and statistical analysis.

Immediately prior to joining the faculty at Johns Hopkins, I directed a program on violence research at the Washington Hospital Center in Washington, DC. I joined the faculty of the Johns Hopkins School of Public Health in 1992, and since 2010 have been a tenured Professor of Health Policy and Management with a joint appointment in the School of Education's Division of Public Safety Leadership. I teach graduate courses on violence prevention. Previously, I taught courses in research and evaluation methods at Johns Hopkins and served on the steering committee of a pre- and post-doctoral training program in violence prevention research funded by the National Institutes of Health and as core faculty on a NIH funded pre- and post-doctoral research program in drug dependence epidemiology.

I have directed numerous studies related to gun violence and its prevention. I have published over 100 articles in scientific, peer-reviewed journals, the vast majority of these addressed some aspect of violence and/or firearm injuries and their prevention. I am the lead editor of a book entitled Reducing Gun Violence in America: Informing Policy with Evidence and Analysis by Johns Hopkins University Press (2013), and am the lead author for two chapters and co-author on three other chapters in this book. In addition, I served as special editor or co-editor of three special issues on gun violence for top tier public health journals. My curriculum vita, detailing these publications, is attached.

The Johns Hopkins Center for Gun Policy and Research was established to conduct rigorous research into gun policy questions, look objectively at all available data, and analyze and report the results. Where the data and research, considered objectively, support a particular policy, we say so. Where the data and research do not support a particular policy, we say that as well. Our goal is not to advance any particular policy or agenda, but to use data and research to inform public policy decisions.

In the past four years I have testified as an expert in the following cases:

- a. *Rocky Mountain Gun Owners v. Hickenlooper*,
Case No. 13CV33879, (City & Cty. of Denver Dist. Ct.)
- b. *Wrenn vs. District of Columbia*,
Civil Action No. 15-00162 (CKK) (D.D.C.)
- c. *Heller vs. District of Columbia*,
Civil Action No. 08-01289 (RMU) (D.D.C.)
- d. *Norberg v. Badger Guns, Inc.*,
No. 10 CV 020655 (Cir. Ct. of Wis., Milwaukee Cty.)
- e. *Lopez vs. Badger Guns, Inc.*,
No. 10 CV 018530 (Cir. Ct of Wis., Milwaukee Cty.,)
- f. *Cook v. Hickenlooper*,
Civil Action No. 13-CV-1300-MSK-MJW (D. Colo.)
- g. *Kolbe v O'Malley*,
No.: 1:13-cv-02841-CCB (D. Md.)

I am being compensated at a rate of \$350 per hour.

THEORY AND RESEARCH EVIDENCE RELEVANT TO MARYLAND'S HANDGUN QUALIFICATION LICENSING REQUIREMENTS

In this report, I will present the underlying theory and empirical evidence that demonstrates that Permit to Purchase (PTP) laws, of which Maryland's HQL requirements is a type, are an effective means of preventing: 1) the diversion of guns for criminal purposes (e.g., straw purchases), 2) homicides, 3) suicides, and 4) possibly, serious injuries and deaths to law enforcement officers.

I. Theory of How Firearm Purchaser Permit/License Requirements Could Reduce Firearm Violence

Requiring all purchasers of handguns and other firearms to acquire a permit or license could reduce the risk of firearm violence in a number of ways. A common way in which firearms are diverted for criminal misuse is through illegal straw purchases, i.e., when someone who is not

prohibited from possessing a firearm buys one for someone who is prohibited or who is planning on using the firearm for criminal purposes (ATF 2000). Without a purchase permit requirement, straw purchases are relatively quick, low-risk encounters for the straw purchaser with the promise of immediate payment for the services by individuals who are legally prohibited from purchasing firearms. Even in states that have a waiting period for handgun purchases, straw purchasers simply have to go into a gun shop, present a government-issued ID, complete a form that the gun shop owner or employee transmits to the FBI and/or state law enforcement agency to complete the transaction. Most states do not require background checks or record-keeping for firearms transfers between non-licensed sellers and purchasers, thus the transfer from the straw purchaser to the prohibited possessor bears little risk or cost to the straw purchaser. States that do have such requirements, but without a purchaser permit or license requirement (as was the case in Maryland prior to the Firearm Safety Act of 2013), rarely prosecute individuals for failure to comply with gun laws.¹ While purchasers must produce government-issued identification, gun shop owners and employees often have no means to verify the authenticity of the ID or to verify that the person wishing to make the purchase is the same as the person identified in the document presented.

In contrast, many PTP laws, including the HQL provision of the Maryland's FSA require purchase applicants be fingerprinted and complete safety training requirements. In addition to reducing straw purchases and ensuring proper identification of handgun purchasers, requiring fingerprinting of firearm purchasers can also aid in prosecutions of individuals who use a gun in a violent crime or illegally transfer the firearm because it can refute a claim by the defendant that

¹ Crifasi CK, Frances M, Vernick JS, Webster DW. (2018) Changes in the legal environment and enforcement of firearm transfer laws in Pennsylvania and Maryland. *Injury Prevention* January 13, 2018 [Epub ahead of print] as 10.1136/injuryprev-2017-042582.

someone else purchased the gun using the defendant's identification. Further, requiring fingerprinting of firearm purchasers allows for identification of HQL holders who are convicted of prohibiting offenses subsequent to purchase and the removal of firearms from those individuals. Thus, the HQL requirement allows police to disarm dangerous individuals.

Among the public safety benefits of the firearm safety training is the potential to positively influence the storage practices of handgun owners in the home by encouraging owners to store handguns unloaded and locked up so that the handguns are not accessible to minors or to thieves. Storing firearms locked and unloaded decreases the risk of youth being injured or killed due to unintentional shootings and suicides (Grossman et al., 2005; Webster et al., 2004),^{2, 3} and would likely reduce the risk of school shootings committed by minors because the majority of school shootings committed by minors involve firearms the youthful shooters brought from their homes.⁴ Surveys of gun owners reveal that unsafe gun storage is common and that gun owners who take gun safety courses are more likely to store their guns locked and unloaded (Crifasi 2018).⁵

Another reason that PTP laws can reduce firearm violence is that the laws are likely to reduce impulse purchases when an individual is angry or despondent and is considering taking a life. Requiring that someone go to be fingerprinted for identity verification and take a safety course

² Grossman DC, Mueller BA, Riedy C, Dowd MD, Villaveces A, Prodzinski J, et al. Gun storage practices and risk of youth suicide and unintentional firearm injuries. *JAMA*. 2005;293(6):707–14. <https://doi-org.proxy1.library.jhu.edu/10.1001/jama.293.6.707>.

³ Webster DW, Vernick JS, Zeoli AM, Manganello JA. (2004) Effects of youth-focused firearm laws on youth suicides. *JAMA* 292:594-601.

⁴ Everytown for Gun Safety, Analysis of School Shootings, January 1, 2013—December 31, 2015 (2016), finding that of shootings perpetrated by minors at primary and secondary schools and for which the source of the firearm was known, more than half of the minors obtained the gun at home (13 of 24 incidents).

⁵ Crifasi, CK, Doucette, ML, McGinty, EE, Webster, DW, Barry, CL. (2018) Storage Practices of US Gun Owners. *American Journal of Public Health* 108(4): 532-537.

requires intention and planning over a matter of days, providing time for the potential impulse buyer to change his or her mind. This is particularly important in the case of suicides because many suicidal acts occur within minutes or hours of a suicidal thought.

II. Evidence That Handgun Purchaser Licensing Laws Reduce the Diversion of Guns for Criminal Use

There have been a number of published research studies of the diversion of guns into the underground market for criminal use that rely upon crime gun trace data. In many law enforcement agencies, police routinely submit information to the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) about the guns that they recover from criminal suspects or crime scenes that allows them to trace the path a gun takes from factory assembly line, to wholesale distributor, to retail gun shop, a purchaser and, ultimately, to a criminal gun possessor. Using the make, model, caliber, and serial number of the firearm, the ATF contacts actors in the supply chain down to the retail seller in order to determine who purchased the firearm and when they purchased it. The ATF⁶ and many leading firearm researchers use crime gun trace data to monitor and study markers of illegal diversion, especially illegal straw purchases and other methods of diverting new guns into the underground market.⁷ A team of top scholars who study the diversion of guns to criminals and have been recognized with numerous honors for their scholarship on this and related topics, thoroughly refuted claims and criticism made by Gary Kleck⁸ about the validity of using proxies for illegal transfers from gun trace data such as relatively brief intervals between retail sale and the guns recovery by law enforcement

⁶ Bureau of Alcohol, Tobacco and Firearms (ATF). *Following the Gun: Enforcing Federal Laws Against Firearms Traffickers*. Washington: Bureau of Alcohol, Tobacco and Firearms; 2000.

⁷ Braga AA, Wintemute GJ, Pierce GL, Cook PJ, Ridgeway G. (2012) Interpreting the empirical evidence on illegal gun market dynamics. *Journal of Urban Health* 89(5):779-793. DOI 10.1007/s11524-012-9681-y.

⁸ Kleck G, Wang S-YK. The myth of big-time gun trafficking and the overinterpretation of gun tracing data. (2009) *UCLA Law Review*. 2009; 56: 1233-1294.

commonly referred to as “time to crime” (TTC). This study by Braga and colleagues demonstrated that: 1) illegal straw purchases account for 41.5% of guns in ATF gun trafficking investigations, 2) that guns traced to crime are “disproportionately concentrated among newer guns” than is the stock of guns owned by civilians, 3) that most of those relatively new crime guns were connected to criminal possessors who were not the original purchasers of the guns, and 4) “data on obliterated serial numbers are very limited and must be used with great caution to avoid incorrect conclusions about illegal gun market dynamics.”

The other key variables in crime gun trace data for understanding how state gun sales regulations are related to the diversion of guns for criminal use are the state in which the firearm was sold and the state in which the firearm was recovered by law enforcement. If a state’s gun laws are relatively effective in keeping firearms from being used in crime, any criminal that does access firearms would have to be more reliant upon guns that are trafficked across state lines. Conversely, if a state’s firearm laws provided inadequate deterrence against illegal diversions of guns, a larger share of its crime guns would come from within-state sources and they would export more guns for criminal use into other states, especially those states with laws that prevent illegal diversions into the criminal market.

A series of studies consistently show negative associations between the presence of PTP or handgun purchaser licensing laws and the share of crime guns with short time-to-crime intervals and with exporting guns for criminal use, and positive associations between PTP laws and the share of crime guns which originated in out-of-state sales. Each of these associations is consistent with the notion that PTP laws deter illegal diversions of guns for criminal use. In a study I published with colleagues in 2009, we analyzed data from the years 2000-2002 in 54 U.S. cities that participated in the Youth Crime Gun Interdiction Initiative (YCGII; Washington, DC,

which essentially banned all handgun sales from 1977 to June 2008, was excluded).⁹ Each YCGII city agreed to submit information to the ATF for all crime guns recovered by local law enforcement agencies, thus reducing the potential problem of guns being selectively traced (e.g., only guns recovered from drug-selling groups). The primary outcome of interest was the percentage of all crime guns that were recovered within 12 months of a retail sale that took place in the same state as the gun was recovered by police, and the purchaser of record was not the criminal possessor. Of the seven cities with the lowest indicator of within-state diversion under 1 year TTC, six (Camden, NJ; Newark, NJ; New York, Boston, Jersey City, St. Louis) had handgun purchase licensing systems. None of the ten cities with the highest level of the intrastate diversion had a handgun purchaser licensing or PTP law. After controlling for other key gun laws, distance to states with weak gun laws, and the number of people living in states with weaker gun laws living within a 50-mile radius of the city, the strongest form of handgun purchaser licensing (allows discretion to deny permits if the background check reveals something indicating the applicant could be dangerous) was associated with 68 percent lower levels of intrastate diversions of guns for criminal use.

We undertook a somewhat similar study using crime gun trace data aggregated at the state level for 2009 to examine the association between state gun sales laws and per capita rate of crime guns exported to criminals in other states after controlling for potential confounders.¹⁰ We found PTP laws were strongly associated with lower levels of crime gun exports. Per capita exporting of crime guns was negatively associated with laws that allowed law enforcement

⁹ Webster DW, Vernick JS, Bulzacchelli MT. Effects of state-level firearm seller accountability policies on firearms trafficking. *Journal of Urban Health* 2009; 86:525-537.

¹⁰ Webster DW, Vernick JS, McGinty EE, Alcorn T. (2013) "Preventing the Diversion of Guns to Criminals through Effective Firearm Sales Laws," pp. 109-122. In Webster DW, Vernick JS, Eds. *Reducing Gun Violence in America: Informing Policy with Evidence and Analysis*. Baltimore, MD: Johns Hopkins University Press.

discretion to deny applications based on dangerousness in applicant's record (-76%, p=.001) and PTP laws that did not allow discretionary denial but did require fingerprinting (-45%, p=.02). Nondiscretionary PTP laws without fingerprinting of applicants were associated with 25% lower levels of crime gun exporting, but the difference was not statistically significant (p=.15). These effects were independent of other laws that the states had including universal background check requirements.

A recent study used crime gun data aggregated at the state level for the years 2006-2016 to examine the association between state gun laws and the share of the state's crime guns that originated from within state retail sales.¹¹ Again, if state gun laws are effective in preventing the diversion of guns for criminal use, a smaller share of their crime guns will have been sold by in-state firearm dealers. In addition to finding strong negative associations between the strength of a state's gun laws and the share of crime guns originating from in-state gun sales, the researchers found that PTP laws had the strongest bi-variate association with lower levels of in-state crime guns and one of the strongest overall protective effects after controlling for the presence of other gun laws. These findings are consistent with those of prior studies.¹²

Most of the studies examining the association between PTP and other gun sales regulations and indicators of diversion or trafficking of guns have not focused on longitudinal associations – whether the gun diversion indicators change when PTP laws change. Observing these longitudinal or temporal associations is critical to the internal validity of a study and to the

¹¹ Collins T, Greenberg R, Siegel M, Xuan Z, Rothman EF, Cronin SW, Hemenway D. (2018) State Firearm Laws and Interstate Transfer of Guns in the USA, 2006–2016. *Journal of Urban Health*. Published online 18 April 2018.

¹² Webster DW, Vernick JS, Hepburn LM. (2001) Relationship between licensing, registration, and other gun sales laws and the source state of crime guns. *Injury Prevention* 7:184–189.

ability to draw causal inferences from the associations.¹³ There have been two opportunities to measure changes in measures of gun diversion for criminal use in response to changes in PTP laws and both have demonstrated strong and clear associations in the direction consistent with PTP laws being protective against such diversions. First, Missouri had a PTP law for handguns that dated back to the 1920s. But state lawmakers repealed Missouri's PTP law as of August 28, 2007. In a 2013 study I used ATF crime gun trace data for the period 2002-2011 for guns recovered in Missouri to depict a sharp increase in the share of crime guns that had been sold a) less than three months prior to police recovery of the weapon, b) three to twelve months prior to recovery, and c) one to two years prior to recovery. What is evident by inspection of the data in Table 8.1 below copied from Webster and Vernick (2013) are sharp increases that coincide with the repeal of Missouri's PTP law.¹⁴ The less than three months TTC guns jump from 3.4% in 2006 to 4.5% in 2007 (four months of which included post-PTP repeal) to 9.4% in 2008, nearly 2.8 times as high as the figure for 2006, and remained elevated through 2011. The shift upward in the crime guns with TTC in the 3 to 12 months range increased sharply beginning in 2008, the first full year the PTP law had been repealed, the levels during 2008-2011 being 2.4 times higher than the levels during the 2002-2006 period when the PTP was in effect (mean of 13.9% vs. 5.7%). The share of Missouri crime guns with a TTC of between one and two years takes a similarly large and abrupt shift upward beginning in 2009, the date of crime guns sale (2007-2008) coinciding with the date of the PTP repeal. Through the most recent year of data available

¹³ Ward AC. (2009) The role of causal criteria in causal inferences: Bradford Hill's "aspects of association. Epidemiological Perspectives and Innovations. 6:2 Published online 2009 Jun 17. doi: 10.1186/1742-5573-6-2.

¹⁴ Webster DW, Vernick JS, McGinty EE, Alcorn T. (2013) "Preventing the Diversion of Guns to Criminals through Effective Firearm Sales Laws," pp. 109-122. In Webster DW, Vernick JS, Eds. Reducing Gun Violence in America: Informing Policy with Evidence and Analysis. Baltimore, MD: Johns Hopkins University Press.

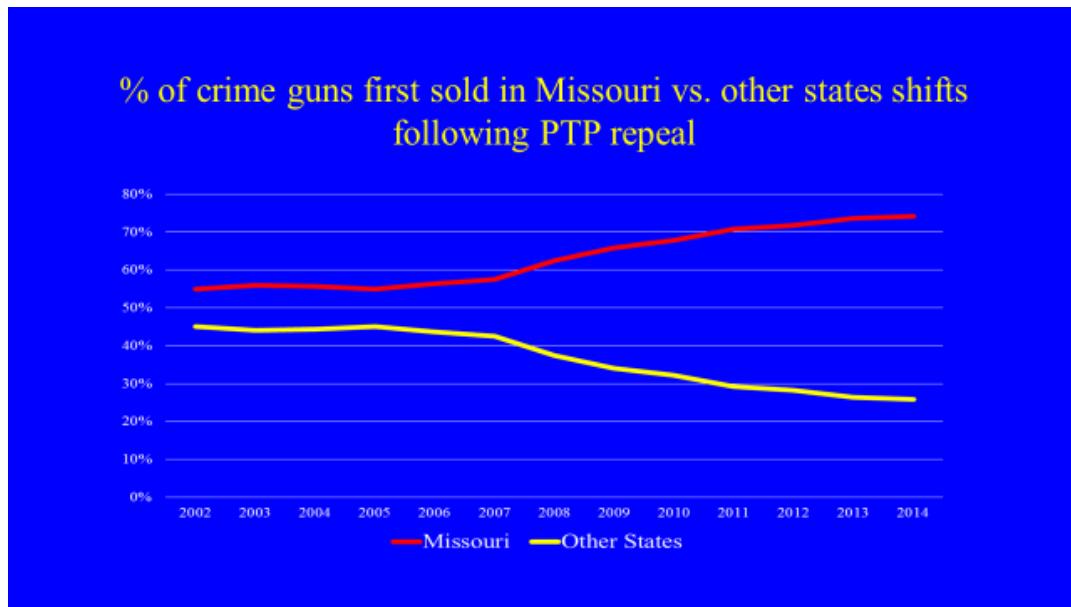
(2016), the share of Missouri crime guns with TTCs under 12 months is 23.7%, which is 2.7 times higher than the pre-PTP-repeal share of 8.7%.¹⁵

Table 8.1 Percentage of Missouri Crime Guns with Short Time Intervals between Retail Sale and Recovery by Police for Years 2002–2011

Year	Up to 3 mont	3–12 mont hs (%)	1–2 year s
2002	2.9	5.2	5.2
2003	3.2	5.3	6.1
2004	2.1	5.6	5.7
2005	3.3	5.1	6.6
2006	3.2	7.5	7.2
2007	4.5	7.9	7.1
2008	9.4	12.6	6.7
2009	8.1	15.0	12.7
2010	7.6	13.7	13.0
2011	8.5	14.3	12.7

Also consistent with the argument that Missouri's repeal of its PTP law was facilitating criminal access to firearms is the fact that the share of crime guns that had been sold in retail transactions within Missouri began trending upward at the time of the repeal from a steady 55%-57% during the 2002-2006 period before the law was repealed to eventually 75% in 2014.

¹⁵ Bureau of Alcohol, Tobacco, Firearms and Explosives. Firearms Trace Data, 2016: Missouri. Accessed May 15, 2018. <https://www.atf.gov/firearms/docs/undefined/2016tracestatsmissouripdf/download>



I was senior author of a recent study led by Dr. Cassandra Crifasi that was published in a special issue of the Russell Sage Foundation Journal for Social Sciences that focused on the latest research on underground gun markets.¹⁶ The study assessed whether crime gun trace diversion metrics changed in response to Maryland's Firearm Safety Act (FSA) of 2013 and its adoption of the HQL requirement. We used granular (gun-level) data from ATF trace of each crime gun recovered by Baltimore Police Department from January 1, 2007 through September 30, 2015 and excluded guns that were found or turned in by citizens but not linked to a crime. We created a time-series of the number of crime handguns that met our primary measure of diversion shortly after a retail sale (sale to crime interval under 1 year and the criminal possessor was not the legal purchaser of record) for handguns sold by licensed dealers in Maryland based on the month in which the handgun was sold by the retailer. We used negative binomial regression models that controlled for baseline trends in the outcome variables, calendar month

¹⁶ Crifasi CK, Choksey S, Bugsy S, Webster DW. (2017) The initial impact of Maryland's Firearm Safety Act of 2013 on the supply of crime guns in Baltimore. *The Russel Sage Foundation Journal for the Social Sciences*, 3(5):128-140.

(to adjust for potential seasonality), and the overall number of handguns recovered by the Baltimore Police Department during the twelve months following a sales month observation (to account for variation in BPD's focus on illegal gun possession arrests). The models also controlled for the number of months handguns sold in a given month were at risk of being recovered by police in order to adjust for the relatively short observation period following the law's implementation and the truncated follow-up period for handguns sold after October 1, 2014. Based on this analysis, the FSA with its HQL requirement was associated with a 76 percent reduction in the number of handguns originally sold in Maryland that were recovered within one year of retail sale and the purchaser was not the same as the possessor. Not surprisingly, this large effect was statistically significant ($p < .05$). Because the HQL could also potentially prevent persons who are legally qualified to purchase firearms from acquiring a gun for criminal purposes, we also measured the effect of the law on criminal involvement of a handgun within 12 months of its purchase within the state of Maryland and found the FSA was associated with a 59 percent reduction in this outcome.

This study also examined whether the FSA of 2013 prompted a shift towards more crime guns originating outside the state as the supply of new Maryland handguns in the underground market was constrained. As was revealed following the repeal of Missouri's PTP law, short TTC metrics can change abruptly following an important change in state gun sales regulations, but changes in the ratio of within-state versus out-of-state crime guns occur more gradually due to the fact that the average age of a crime gun is 8 to 12 years. In the case of Maryland's FSA of 2013, we observed a 20 percent increase in the number of out-of-state handguns recovered by police; however, this was not statistically significant. We obtained additional crime gun trace

data through April 2018 from the Baltimore Police Department which revealed the continued shift toward a greater share of crime guns originating from outside of the state (see below).

This study was the first of its kind to combine data from crime gun traces with survey data from persons on parole or probation by the State to assess their experiences and perceptions of the effect of a gun control law on the ease of acquiring a firearm. We surveyed 195 men who were recruited outside Maryland State parole and probation offices in Baltimore during May and June 2016. Men who asserted that they were over the age of eighteen, currently on parole or probation, and Baltimore residents were invited to complete an anonymous survey after eligibility was determined via screening questions. Surveys were self-administered using a closed-ended computerized survey instrument with audio assistance to ensure confidentiality and prevent low literacy from affecting survey participation. This was a high-risk population evidenced by the fact that 63 percent reported that they had been shot or shot at, 48 percent had been shot or shot at multiple times. Forty-one percent of respondents reported that the new gun laws had made it more difficult to get a gun and forty percent indicated that the law had made it more costly to acquire a gun. Of the 172 who responded to the question with a “yes” or “no”, 38% said the law made it more difficult to get someone to buy a gun on their behalf. These survey findings are consistent with the findings from the analyses of crime gun trace data that demonstrate a dramatic decline in guns diverted into the criminal market soon after retail purchase.

III. Evidence that Handgun Purchaser Licensing Laws Reduce Homicides

A number of studies, as well as new data I present in this report below use a variety of methodologies and provide evidence that handgun purchaser licensing or Permit to Purchase (PTP) laws reduce homicides committed with firearms. Currently, ten states and the District of

Columbia has some form of purchaser licensing or permitting requirement for handguns. Efforts to estimate the impacts of these laws are difficult because the laws were implemented over a century. Thus many studies designed to estimate the effects of PTP laws over a defined time study period include data for states that had PTP laws throughout the study period and thus there were no changes to observe and data from other states that changed their PTP law status over the study period. I start with a study I co-authored with Cassandra Crifasi that was just published in the *Journal of Urban Health*.¹⁷ We used death certificate data from Centers for Disease Control and Prevention for the period 1984-2015 to track annual firearm homicides in large metropolitan counties (136 US Census urbanizations codes of “Large Central Metro” and “Large Fringe Metro,” and populations greater than 200,000). We focused on these counties because firearm homicide is highest in urban areas. To estimate the effects of PTP and several other laws directly relevant to gun violence (comprehensive background check requirements absent PTP, firearm prohibitions for violent misdemeanants, Shall Issue Right to Carry laws that make it easy for civilians to carry concealed firearms, and so-called Stand Your Ground Laws) while also controlling for factors associated with homicide including poverty, unemployment, population that were Black males ages 15-24 years, changes in incarceration rates, and law enforcement expenditures. The mixed-effects Poisson regression models also included random intercepts for counties and year fixed effects to account for national trends. Through these analyses we estimate that PTP laws were associated with a statistically significant 14% reduction in firearm homicide rates. If PTP laws were also associated with reductions in homicides that did not involve firearms, we would be concerned that the estimate was biased due to omitted variables

¹⁷ Crifasi CK, Merrill-Francis M, McCourt A, Vernick JS, Wintemute GJ, Webster DW. Association between Firearm Laws and Homicide in Large, Urban U.S. Counties. *Journal of Urban Health*, Published online 21 May 2018. <https://doi.org/10.1007/s11524-018-0273-3>

that were associated with PTP laws and homicides. However, PTP laws were not associated with changes in rates of non-firearm homicides which is consistent with the hypothesis that the reduction in firearm homicides coincident with PTP is causal and that the protective effects are not negated by homicide method substitution.

Because the specific effect of Maryland's PTP law was not the goal of this study, we did not report any Maryland-specific findings in our research article. We did, however, examine the PTP law effects on Maryland urban jurisdictions in subsequent analyses for the purposes of this report and to respond to arguments put forth by the plaintiff's experts that Maryland's PTP/HQL requirements do not confer public safety benefits. Drs. Kleck and Moody claim that the HQL requirement of the FSA could not possibly be having a positive impact because homicides in Baltimore City and the state have risen during 2015-2017. Baltimore City has historically been the local jurisdiction with the majority of the state's homicides involving firearms. Many things affect homicide trends in Baltimore including changes in illegal drug markets, conflicts between gangs, and what is going on in policing. It is well known that Baltimore City experienced dramatic riots and civic unrest in late April and May 2015 following the in-custody death of Freddie Gray. These events occurred 18 months after the HQL requirement went into effect in October 2013. It is commonly known and well-documented that dramatic civil unrest prompted by actions taken by police are often followed by sharp increases in violent crime. Such sharp and dramatic increases in violent crime following such events has been attributed to "de-policing" and to a crisis in the legitimacy of law enforcement in alienated minority communities where gun violence is concentrated.¹⁸ Indeed, the phenomena of de-policing followed by surge in violent

¹⁸ Rosenfeld R, Gaston S, Spivak H, Irazola S. Assessing and Responding to the Recent Homicide Rise in the United States. National Institute of Justice, U.S. Department of Justice, NCJ 251067, November 2017.

crime has been documented specifically for Baltimore City following the riots in 2015.¹⁹ Given these well-known facts, it is surprising that Dr. Moody's analyses neglected to consider the important historical confounders in Maryland's 2015 and 2016 firearm homicide rates that were exclusive to Baltimore City. Indeed, Dr. Moody does note that the reduction in Maryland's firearm homicide rate in 2014, prior to the riots in Baltimore City, was much steeper than the comparison states in his synthetic control analysis. "Clearly, the drop in the firearm homicide rate in Maryland in 2014 is highly unusual and would indicate a great success if it had continued." (Moody report 7).

Thus, in our study of homicide rates in large urban counties, we created separate variables to estimate the unique effects of Maryland's FSA and HQL requirement on Baltimore City versus the other large metropolitan counties (Anne Arundel, Baltimore County, Montgomery County, Prince George's County). The coefficients converted into Incident Rate Ratios from this analysis are copied below and reveal 1) that the FSA with its HQL requirement was associated with a large 48 percent reduction in firearm homicide rates in the urban jurisdictions that were not Baltimore City (variable label PTP_MDbaltcity), and 2) the same law was associated with a 28 percent increase in Baltimore City (variable label PTP_MDnobaltcity). Both of the estimated Maryland PTP law effects are highly significant, i.e., there is an extremely low probability that the observed effects were due to chance fluctuations in firearm homicides. But the estimate for Baltimore City is clearly biased toward more homicides because the post-PTP period overlaps with the post-unrest surge in homicides that has haunted the city through 2017. Indeed, a study that I led of homicides and nonfatal shooting trends in Baltimore City during 2004-2017 that

¹⁹ Morgan SL, Pally JA. (2016) Ferguson, Gray, and Davis: An Analysis of Recorded Crime Incidents and Arrests in Baltimore City, March 2010 through December 2015. Johns Hopkins University. <http://socweb.soc.jhu.edu/faculty/morgan/papers/MorganPally2016.pdf>

accounted for the impacts of a variety of policing and prevention efforts directed at gun violence in Baltimore neighborhoods estimated that the unrest increased homicides by 51%-55% and nonfatal shootings by 58%-64%.²⁰ Thus, the estimated 28 percent increase in firearm homicide rates in Baltimore City during the period in which the PTP law was in place is not surprising and does not reflect true causal effects of the law change.

Output from Stata from mixed-effects Poisson regression analysis of firearm homicide rates for 136 urban counties.

Mixed-effects Poisson regression		Number of obs	=	4,206
Group variable: countycode		Number of groups	=	136
Obs per group:				
		min	=	25
		avg	=	30.9
		max	=	31
Integration points = 7		Wald chi2(42)	=	18944.17
Log likelihood = -19882.965		Prob > chi2	=	0.0000

firearmhomicide	IRR	Std. Err.	z	P> z [95% Conf. Interval]
-----+-----				
PTP_noMD	.8911427	.0229988	-4.47	0.000 .8471869 .9373792
PTP_MDbaltcity	.5242726	.059731	-5.67	0.000 .419352 .655444
PTP_baltcity	1.281044	.1085327	2.92	0.003 1.085047 1.512445
CBC_only	1.158632	.0129142	13.21	0.000 1.133595 1.184222
RTC_any	1.04536	.0102931	4.51	0.000 1.025379 1.06573
SYG	1.072739	.0123357	6.11	0.000 1.048832 1.097191
VM	1.144021	.0131459	11.71	0.000 1.118543 1.170079
AAMaleYouthPer	1.533046	.0209053	31.33	0.000 1.492615 1.574573
povrate_county	.9995003	.0021285	-0.23	0.814 .9953373 1.003681

²⁰ Webster DW, Buggs SAL, Crifasi CK. Estimating the Effects of Law Enforcement and Public Health Interventions to Reduce Gun Violence in Baltimore. Johns Hopkins Center for Gun Policy and Research, Johns Hopkins Bloomberg School of Public Health, January 2018.

unemprate_county	1.004281	.0020225	2.12	0.034	1.000325	1.008253
incarc_rate	.9999652	.0000414	-0.84	0.400	.9998841	1.000046
leo_expend100k	.9945243	.0001629	-33.52	0.000	.9942051	.9948436
yearcode						
1985	1.013614	.0174395	0.79	0.432	.9800032	1.048378
1986	1.136108	.0190907	7.59	0.000	1.0993	1.174148
1987	1.122748	.019263	6.75	0.000	1.085621	1.161145
1988	1.26369	.0216667	13.65	0.000	1.22193	1.306878
1989	1.37544	.0238321	18.40	0.000	1.329514	1.422952
1990	1.614118	.0271746	28.44	0.000	1.561726	1.668268
1991	1.705069	.0283562	32.09	0.000	1.650388	1.761561
1992	1.66259	.0282574	29.91	0.000	1.608119	1.718907
1993	1.729868	.030083	31.51	0.000	1.6719	1.789845
1994	1.632285	.0295349	27.08	0.000	1.575412	1.691211
1995	1.426321	.027121	18.68	0.000	1.374143	1.48048
1996	1.25451	.0248359	11.45	0.000	1.206765	1.304144
1997	1.155818	.0237346	7.05	0.000	1.110223	1.203286
1998	1.024061	.0220055	1.11	0.269	.9818269	1.068112
1999	.9418771	.0209189	-2.70	0.007	.9017564	.9837829
2000	.9566648	.0213991	-1.98	0.048	.9156294	.9995393
2001	.8171034	.0176464	-9.35	0.000	.7832389	.8524322
2002	1.023366	.0217487	1.09	0.277	.9816151	1.066893
2003	.8306659	.0173861	-8.86	0.000	.7972792	.8654507
2004	.9971146	.0217538	-0.13	0.895	.9553766	1.040676
2005	1.060781	.0234798	2.67	0.008	1.015746	1.107814
2006	1.096444	.0246662	4.09	0.000	1.04915	1.145871
2007	1.066003	.0243311	2.80	0.005	1.019366	1.114774
2008	1.007524	.0228908	0.33	0.741	.9636433	1.053403
2009	.9032997	.0208078	-4.41	0.000	.863424	.9450169
2010	.8747842	.0203588	-5.75	0.000	.8357782	.9156107
2011	.8474495	.0196532	-7.14	0.000	.8097923	.8868579
2012	.8802334	.0202548	-5.54	0.000	.8414165	.9208409
2013	.8474369	.019932	-7.04	0.000	.8092578	.8874173
2014	.8477609	.0208556	-6.71	0.000	.8078545	.8896387

```

|
_cons | .0000182 1.26e-06 -156.89 0.000 .0000158 .0000208
ln(Population) | 1 (exposure)

-----
Random-effects Parameters | Estimate Std. Err. [95% Conf. Interval]
-----
countycode: Identity |
sd(_cons) | .7345803 .0460396 .6496665 .8305925

-----
LR test vs. Poisson model: chibar2(01) = 32744.22 Prob >= chibar2 = 0.0000

. estat ic

```

A separate study of state-level homicide rates during 1980-2011 attempted to estimate the effects of PTP laws and found a negative association between PTP laws and homicide rates that was not statistically significant.²¹ However, in that study, the researcher coded California and Nebraska as each having PTP laws when they do not. In neither of these states is it a requirement that handgun purchasers first obtain a permit or license to purchase a handgun before they can legally purchase a firearm from a licensed dealer. The researcher also coded Missouri as having adopted PTP in 1981 when the state has had a PTP requirement for handguns dating back to the 1920s. As a result of these basic errors of measuring PTP laws, the estimates of the impact of PTP laws on homicides from this study are not valid.

Firearm ownership by domestic violence offenders can elevate the risk of intimate partner homicides by five-fold above that of unarmed abusers after controlling for other factors.²² Many

²¹ Gius M. (2017) Effects of Permit-to-Purchase Laws on State-Level Firearm Murder Rates. *Atlantic Economic Journal* 45:73–80. DOI 10.1007/s11293-016-9529-z

²² Campbell JC, Webster DW, Koziol-McLain J, et al. (2003) Risk factors for femicide within physically abusive intimate relationships: Results from a multi-site case control study. *American Journal of Public Health* 93:1089-97.

domestic violence offenders are prohibited from possessing firearms; however, weaknesses in laws such as gaps in background check requirements and lack of a licensing system for firearm purchasers can weaken the effects of such laws. In a recent study that I co-authored with Dr. April Zeoli and others, we studied state-level variation in rates of intimate partner homicide for the years 1980-2013.²³ We statistically controlled for state fixed effects, percentage of the population that was married, percentage that was divorced, the ratio of women to men aged 25 years and older with a college education, poverty levels, the level of monetary aid (adjusted for inflation) to low-income families of four through Aid to Families with Dependent Children/Temporary Assistance to Needy Families, funding each state received each year from the federal STOP Violence Against Women Grant Program, unemployment levels, the number of police officers per capita lagged by one year, proxy measures for gun ownership, and the rate of non-intimate partner homicides for adults aged 25 years and older to control for general homicide trends in the states over time. We found several firearm restrictions to be significantly and negatively associated with intimate partner homicide rates including PTP laws. PTP laws were independently associated with an 11 percent reduction in intimate partner homicide rates (p=.040).

As explained above, the ability to make causal inferences from observed associations between interventions such as firearm laws, requires that the associations be temporal in nature, i.e., that statistical tests focus on how outcomes such as homicides change in relation to change in the laws. In addition to Maryland's PTP law in 2013, the most recent PTP law changes were Connecticut's adoption of PTP that went into effect October 1, 2015 and Missouri's repeal of its

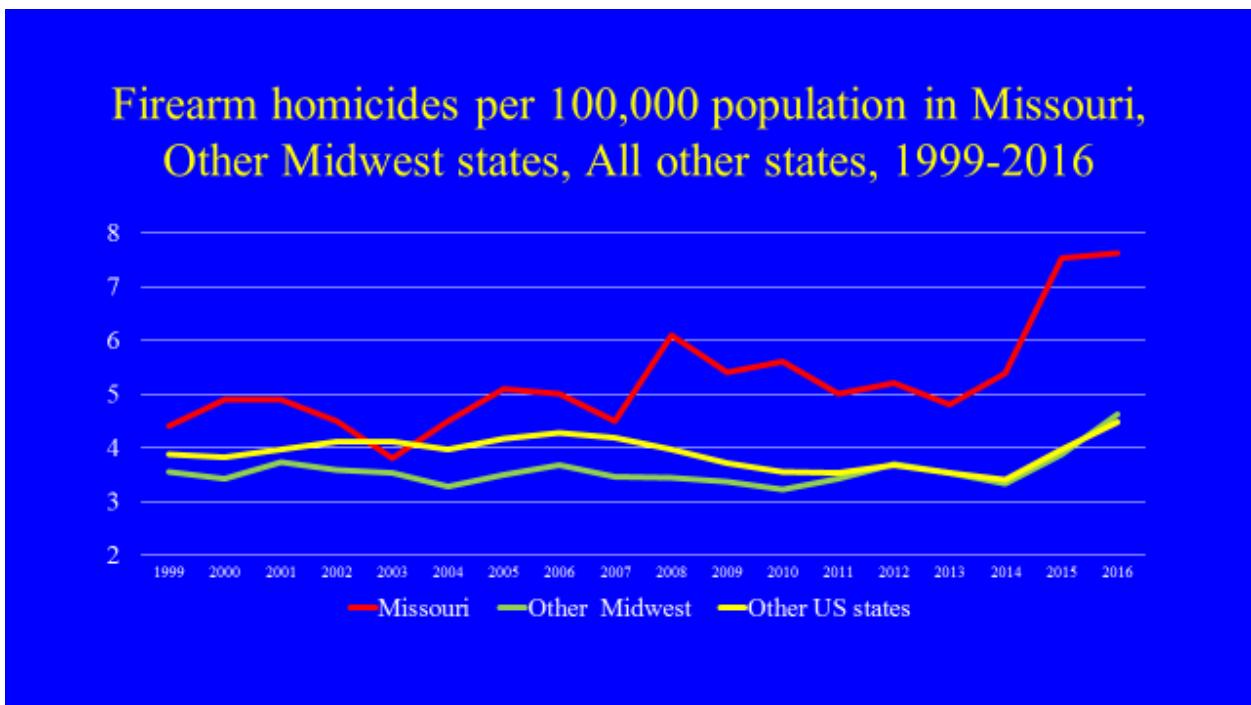
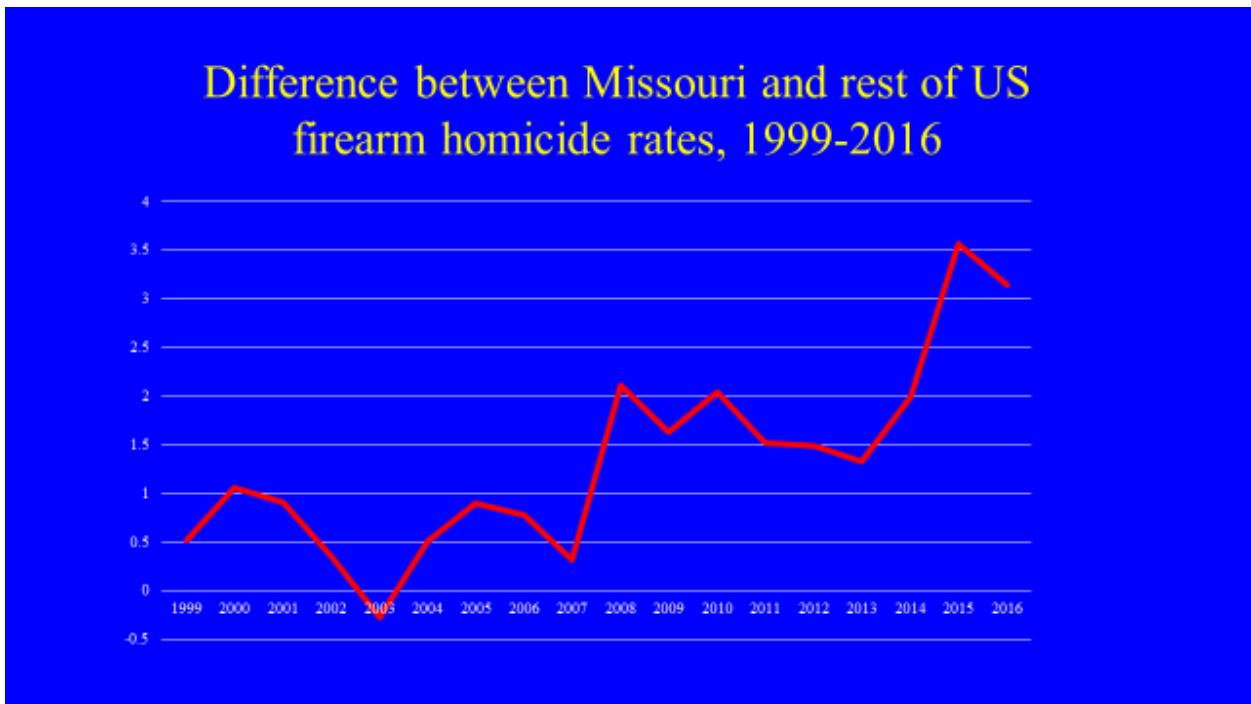
²³ Zeoli AM, McCourt A, Buggs S, Lilley D, Frattaroli S, Webster DW. (2017) Analysis of the strength of legal firearms restrictions for perpetrators of domestic violence and their impact on intimate partner homicide. *American Journal of Epidemiology* E-pub before print 2017 November 29. <https://doi.org/10.1093/aje/kwx362>

PTP law effective August 28, 2007. My colleagues and I estimated the impact of Connecticut's PTP law on homicides during the first 10 years the law was in effect in a study published in the American Journal of Public Health.²⁴ This study applied a research design and analytic technique known as synthetic control analysis that has been widely adopted in policy impact studies where some potential non-intervention comparison units (e.g., states that do not adopt the policy change) are far better matches with the states with the policy changes under study. The method uses values of the outcome variable (e.g., homicide rates) as well as covariates associated with the outcome variable to develop weights that minimize prediction error for the outcomes under study. Using this method with the following covariates - population size, population density (log-transformed), proportion aged 0 to 18 years, proportion aged 15 to 24 years, proportion Black (log-transformed), proportion Hispanic (log-transformed), proportion aged 16 years or older living at or below poverty, income inequality, per capita individual income, number of jobs per adult, proportion of population living in metropolitan statistical areas, law enforcement officers per 100,000 residents, and robbery rates – were used to generate the weights for states in the comparison pool (all states that did not have a PTP law in 1995) that minimize prediction error during the pre-law period 1984-1994. The model for firearm homicide rates for Connecticut produced prediction error that was one tenth the prediction error that would have occurred if all data from all non-PTP states were used to predict Connecticut's firearm homicide rate, validating the strength of this analytic technique. Using this methodology to estimate the counterfactual, we found that Connecticut's PTP law was associated with a 40 percent reduction in its firearm homicide rate over the first 10 full years the law was in effect. We used placebo permutation tests for the non-PTP comparison states to determine how unique Connecticut's reduction in

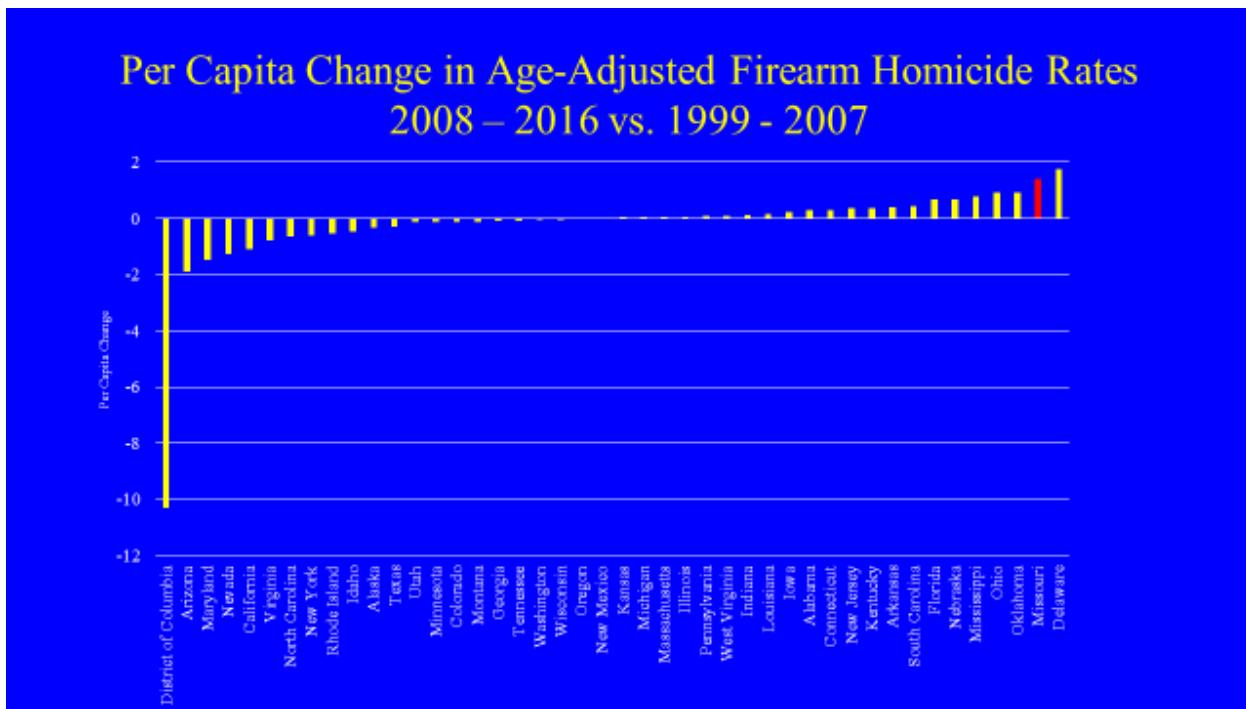
²⁴ Rudolph KE, Stuart EA, Vernick JS, Webster DW. (2015) Association between Connecticut's permit-to-purchase handgun law and homicides. American journal of public health 105(8):e49-e54.

firearm homicide rates were. In the 26 comparison states with acceptable model fit, none experienced greater change in predicted firearm homicide rates than did Connecticut. Consistent with the theory that PTP laws prevent homicides by limiting firearm access to high-risk individuals and evidence that the causal factor is specific to firearms, Connecticut's PTP law was not associated with a significant change in non-firearm homicide rates.

There have been several studies of the impact of Missouri's repeal of its PTP law on August 28, 2007 on homicide rates that will be reviewed below. Each study identifies an abrupt increase in Missouri's firearm homicide rate beginning in 2008 and, contrary to the claims by Gary Kleck, this is not a one-year blip but is sustained over study periods that include up to eight years of post-repeal data and is statistically unique rather than due to random fluctuation. Below is a graph of Missouri's firearm homicide rate minus the firearm homicide rate of the rest of the states and the District of Columbia. During the recent years in which Missouri's PTP law was in place (1999-2006), Missouri's rate per 100,000 population hovered around 0.5 higher than that of the other states and then abruptly jumps to 2.0 higher than in 2008, the first full year the PTP law was not in place. Missouri's firearm homicide rate relative to the other states drifts downward to 1.4 by 2013, but then increases again at a new level greater than 3.0 in 2015 and 2016. The next figure depicts Missouri's firearm homicide rate, the population-weighted rate for other states in the Midwest, and the rate for the US overall. This also reveals a separation in Missouri's firearm homicide rate from that of national or regional comparisons that increases abruptly in 2008 and is sustained through 2016.



Indeed, only one state experienced a larger increase in per capita firearm homicide rates between the baseline period of 1999-2006 and the post-PTP repeal period of 2008-2016 than has Missouri (Delaware). The distribution of changes in the average per capita age-adjusted firearm homicides across states and the District of Columbia is depicted in the graph below between the time period before and after Missouri repealed its PTP law. Most states either had essentially no change over this period and many had reduced firearm homicide rates from the baseline period.



In 2014, my colleagues and I published a study in the American Journal of Public Health that estimated the effects of Missouri's repeal of its PTP law. In this study, we estimate the impact of the law during a period of relative stability in firearm homicide rates across states (1999-2012). Prior studies of firearm laws that include the period of 1985-1995 have been vulnerable to bias

from omitted variables, most importantly the crack cocaine epidemic that led to surging firearm homicide rates, especially among non-White urban youth, but affected homicides differently across states and across time. We used regression analyses to estimate policy change effects while controlling for changes in rates of unemployment, poverty, incarceration, burglary, law enforcement officers per capita, and the presence of four other types of state laws potentially most directly relevant to lethal violence for which there was significant change during the study period. These laws included so-called Stand Your Ground laws, right-to-carry (RTC) laws, bans of unsafe handguns including so-called Saturday Night Specials, and firearm prohibitions for young adults resulting from convictions for serious crimes adjudicated in juvenile courts. Using CDC data from death certificates our analyses found that the repeal of Missouri's PTP laws was associated with a 25 percent increase in the firearm homicide rate (an average annual increase of 1.18 firearm homicides per 100,000 population) through 2010 representing 68 additional firearm homicides annually. The PTP repeal was unrelated to changes in non-firearm homicide rates. Using data from the FBI's Uniform Crime Reports data from law enforcement agencies available through 2012, Missouri's PTP repeal was associated with a 14 percent increase in annual murder rates or 0.81 additional murders per 100,000 population representing 49 additional murders per year.

There have been additional studies that use additional years of data and different analytic methods, but each confirms that the repeal of Missouri's PTP law led to significant increases in firearm homicide rates of the approximate magnitude of my 2014 study. In one such study I co-authored with lead author Raiden Hasegawa and Dylan Small, both statisticians from the University of Pennsylvania's Wharton School, we use a statistical technique known as

bracketing to generate estimates of the repeal of PTP in Missouri on homicide rates in the state.²⁵ Most studies of gun laws and other public policies use some form of a comparative interrupted time-series design and a difference-in-difference estimator. The estimates from such approaches can be biased for estimating the causal effects if there is an interaction between historical confounders (unmeasured conditions that result in changes in the outcome variable under the treatment condition that are unique to the treated versus controls) and study group (law versus no law) during the post-law period. For example, Missouri's repeal of PTP coincided with the Great Recession and the effect of that economic shock could potentially be different between Missouri compared to surrounding states. Missouri also had higher baseline (pre-repeal) firearm homicide rates than its neighboring states. When there is no control state that is completely comparable to the state with the intervention (e.g., Missouri), a bracketing approach is recommended to distinguish the law's true effects from plausible biases by using one comparison group of states that tends to be higher than the state with the intervention and one comparison group that tends to be lower than the intervention state on the outcome.²⁶ To avoid regression to the mean, we use data from 1994-1998 to choose the upper and lower control groups. The lower control group is Iowa, Kansas, Kentucky, Nebraska and Oklahoma and the upper control group is Arkansas, Illinois and Tennessee. The population-weighted firearm homicide rate in the before period of 1999-2007 is 5.2/100,000 population for the upper control group, quite comparable to Missouri's 4.7, and 2.7 in the lower control states respectively. Using annual data for the years 1994-2016 and a standard difference-in-difference estimator we find that Missouri's PTP law is associated

²⁵ Hasegawa RB, Webster DW, Small DS. Time-Series Design to Address Concerns about History Interacting with Group: Evaluating Missouri's Handgun Purchaser Law. Under review *Epidemiology*.

²⁶ Campbell, Donald T. (1969) *Prospective: Artifact and control*. In *Artifacts in Behavioral Research*: Robert Rosenthal and Ralph L. Rosnow's Classic Books, pages 351-382. Academic. Also, Rosenbaum, Paul R. (1987) The role of a second control group in an observational study. *Statistical Science*, 2(3):292-306.

with a 24 percent increase in firearm homicide rates (an additional 1.2 firearm homicides per 100,000 population per year) and the 95% confidence interval for the estimate is +18% to +31%. Using the bracketing approach, we estimate the PTP repeal effect was a 27% increase in firearm homicide rates (95% confidence interval: +19 to +35%) using the upper control border states and a 17% increase using the lower control border states (95% confidence interval: +11% to 23%). To rule out concerns about a possible “Ferguson Effect” resulting from the riots that occurred in August 2014 in Ferguson, Missouri might bias our estimates upward, we estimated the models with data only through 2013. The estimates did not materially affect the point estimate for PTP law effects on firearm homicide rates nor inferences about statistical significance.

Another new study examines the effects of Missouri’s PTP law repeal through the year 2013 and extends prior research on extensions of the synthetic control method for estimating the intervention effects in observational studies and how the effects vary among subgroups of interest. Using this approach, economist Morgan C. Williams, Jr. (City University of New York and National Bureau of Economic Research) derives an estimate of the overall effect of Missouri’s repeal of PTP as a 17% increase in murders (an additional 0.97 murders per 100,000 population per year).²⁷ The harmful effects estimated in Williams’ study were particularly concentrated among Black victims who had an increase of 5.17 additional deaths per 100,000 over the post-repeal period that was associated with the PTP repeal. Among Black youth ages 15-24, the PTP repeal was linked with a 33 percent increase in firearm homicide rates, 29 additional deaths per 100,000 population. Through this study, Dr. Williams also documents evidence that the change in law in 2007 led to an increase in the availability of firearms among

²⁷ Williams, Morgan C., Jr. Gun Violence in Black and White: Evidence from Policy Reform in Missouri. April 17, 2018. http://morganwilliamsjr.com/wp-content/uploads/2015/06/WilliamsJr_Morgan_WP_April_2018.pdf

Missourians based on increases in the ratio of firearm suicides to total suicides and unusually high numbers of firearm sales as indicated by background checks. Considering this evidence along with the data presented in the section above showing an increased rate of diversion of guns for criminal use shortly after a retail sale, there is ample evidence that the repeal of the PTP law increased Missourians' exposure to firearms, a likely mechanism for increasing firearm homicides but not changing non-firearm homicides.

Regardless of methodology, several studies focused on estimating the effects of the repeal of Missouri's PTP law find the law was associated with a substantial increase in firearm homicides.

IV. Evidence that Permit to Purchase Laws Reduce the Risks of Law Enforcement Officers Being Shot in the Line of Duty

Based on the evidence that PTP laws reduce the availability of firearms for criminal use, it is likely that the laws reduce the risk that law enforcement officers face of being shot in the line of duty. My colleague Cassandra Crifasi led a study that I coauthored to examine this question.²⁸ Data for the outcomes of interest were from the FBI's Law Enforcement Officers Killed and Assaulted database which includes data from reports of every line-of-duty fatal assaults and non-fatal assaults committed with a firearm or knife that result in an injury and the analyses were based on annual counts of these events by state and year. Data for fatal assaults of officers were available for the period 1984–2013 for fatal assaults and for 1998–2013 for non-fatal assaults. There were only two PTP law changes to study during the time period for analyses of fatal assaults (Connecticut's 1995 PTP law and Missouri's repeal of PTP in 2007) and only the PTP

²⁸ Crifasi CK, Pollack K, Webster DW. (2015) The influence of state-level policy changes on the risk environment for law enforcement officers. *Injury Prevention* 2015 Dec 30. pii: injuryprev-2015-041825. doi: 10.1136/injuryprev-2015-041825. [Epub ahead of print] PMID: 26718550.

change for Missouri could be examined in the analyses of nonfatal assaults. Because these assaults are rare in a given state and year, the precision of estimates have wide confidence intervals and relatively large point estimates are not statistically significant at the traditional .05 level. In regression models that controlled for state-aggregated law enforcement expenditures, arrest rates for violent crimes, the number of sworn law enforcement officers, poverty, the percentage of the population living in Metropolitan Statistical Areas, and a proxy for gun availability (ratio of firearm suicides to total suicides), Right to Carry Laws, and Three Strikes You're Out laws. Each of the estimates were in the hypothesized direction; Connecticut's PTP law associated with an 80 percent reduction in fatal assaults of officers and Missouri's repeal of PTP was associated with a 52 percent increase; however these effects were not statistically significant. Nonfatal assaults committed with handguns against officers more than doubled after Missouri's PTP law was repealed (IRR=2.14, p=.089). Thus the pattern of the associations in this study are consistent with the notion that PTP laws protect law enforcement officers from being shot in the line of duty.

V. Effects of Permit to Purchase Laws on Suicides

There is an overwhelming amount of research evidence that access to firearms substantially increases suicide risks.²⁹ Although most gun control laws are intended to reduce access to firearms among individuals at risk for committing acts of violence against others, interpersonal and self-directed violent behavior share many risk factors. PTP laws could both effectively screen out and prevent firearm access among individuals at high risk of suicide and also prevent impulsive firearm acquisitions that occur when a person is temporarily suicidal. Several studies

²⁹ Miller M, Barber C, Azrael D, White R. (2013) Firearms and suicide in the United States: is risk independent of underlying suicidal behavior? *American Journal of Epidemiology* 15;178(6):946-945.

have examined the association between PTP laws and suicide rates and consistently found that PTP laws were associated with lower rates of suicide in a state after controlling for potential confounders.^{30,31} One limitation of this research is that most of the variation examined in these studies was cross-sectional and did not isolate if or how suicide rates changed following changes in PTP policies. My colleague Cassandra Crifasi and I used synthetic control methods to minimize prediction errors with state-level suicide data and factors correlated with suicide rates for the years 1981-2012 to estimate the effects of the PTP law changes in Connecticut and Missouri explained above.³² Using this method we estimated a 15.4 percent reduction in firearm suicide rates associated with Connecticut's PTP law and a 16.1 percent increase in firearm suicide rates associated with the repeal of Missouri's PTP law.

Conclusions From the Available Data on Permit to Purchase Handgun Laws

The evidence described above offers consistent and compelling evidence that Permit to Purchase (PTP) laws save lives by preventing intimate partner homicides, firearm homicides generally, suicides, and, most likely, officers being shot in the line of duty. There is sound underlying theory for how PTP laws could affect these outcomes as well as data demonstrating the mechanisms of the causal effects such as preventing the diversion of guns for criminal use. Importantly, we have data indicating how Marylanders are benefiting from the law with reductions in firearm homicides in urban jurisdictions with the exception of Baltimore City during a period of turmoil in the city. Requiring prospective purchasers of handguns to obtain

³⁰ Andrés AR, Hempstead K. (2011). Gun control and suicide: the impact of state firearm regulations in the United States, 1995–2004. *Health Policy* 101(1):95–103.

³¹ Fleegler EW, Lee LK, Monuteaux MC, Hemenway D, Mannix, R. (2013). Firearm legislation and firearm-related fatalities in the United States. *JAMA intern. Med.* 173(9):732–740.

³² Crifasi CK, Meyers JS, Vernick JS, Webster DW. (2015) Effects of changes in permit-to-purchase handgun laws in Connecticut and Missouri on suicide rates. *Preventive Med.* Jul 23, 2015. pii: S0091-7435(15)00229-7

permits or licenses for such purchases is one of the most effective policies for reducing gun violence in America.

May 25, 2018

Date



Daniel Webster, Sc.D.

SUPPLEMENT TO EXPERT REPORT OF DANIEL WEBSTER, ScD

Pursuant to Rule 26(e), I submit this supplement to my expert report previously prepared in this matter. There are two recently published studies of the effects of state firearm laws on homicides that I cited and described in my report that I recently discovered had some incorrect data on the presence or timing of the laws under study. I have contacted the journals in each case to make the corrections.

In our study by Crifasi et al. (2018)¹ of the effects of state firearm policies on homicide rates in large urban counties, the revised estimate of the effect of permit to purchase (PTP) laws for handguns changed from an estimated 14% reduction in firearm homicides to an 11% reduction in firearm homicides. As with the prior estimate, our revised estimate is statistically significant and there is a great deal of overlap between the confidence intervals of the point estimates for the published study and the estimates from our revised analysis that we submitted for an erratum with the *Journal of Urban Health*.

I used the dataset for this study to derive estimates of the effects of the adoption of Maryland's Firearm Safety Act with its HQL provision on large urban counties in Maryland and separated by Baltimore City versus the other jurisdictions. With the revised data on some of the laws, our estimates for the effects in the Maryland jurisdictions were largely unchanged from what I included in my original expert report in this case; we

¹ Crifasi CK, Merrill-Francis M, McCourt A, Vernick JS, Wintemute GJ, Webster DW. Association between Firearm Laws and Homicide in Large, Urban U.S. Counties. *Journal of Urban Health*, Published online 21 May 2018. <https://doi.org/10.1007/s11524-018-0273-3>

continue to see statistically significant large reductions in firearm homicide rates in the large urban jurisdictions excluding Baltimore City.

The other study affected by errors in some of the gun law variable was the one I coauthored with April Zeoli (2017)² that examined the effects of gun laws on intimate partner homicides. In our published paper, we found that PTP laws were associated with a statistically significant 10% reduction in intimate partner homicides. However, in the revised analyses with the corrected law data, the association between PTP laws and intimate partner homicide rates is no longer statistically significant. The editors from the American Journal of Epidemiology requested a retraction and a revision that will replace the retracted article.

Aug. 1, 2018

Date



Daniel Webster

² Zeoli AM, McCourt A, Buggs S, Lilley D, Frattaroli S, Webster DW. (2017) Analysis of the strength of legal firearms restrictions for perpetrators of domestic violence and their impact on intimate partner homicide. *American Journal of Epidemiology* E-pub before print 2017 November 29. <https://doi.org/10.1093/aje/kwx362>

Declaration Exhibit 3

REDUCING GUN VIOLENCE IN AMERICA

**Informing Policy with
Evidence and Analysis**

Edited by

**DANIEL W. WEBSTER
and JON S. VERNICK**

Foreword by

MICHAEL R. BLOOMBERG



Reducing Gun Violence in America

Informing Policy with Evidence and Analysis

EDITED BY

Daniel W. Webster, ScD, MPH,
and Jon S. Vernick, JD, MPH

Center for Gun Policy and Research
Johns Hopkins Bloomberg School of Public Health

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Preventing the Diversion of Guns to Criminals through Effective Firearm Sales Laws

Daniel W. Webster, Jon S. Vernick, Emma E. McGinty,
and Ted Alcorn

Weaknesses in Federal Gun Laws Which Enable Criminals to Get Guns

Preventing individuals who are deemed too risky or dangerous from obtaining firearms is arguably the most important objective of gun control policies. Many perpetrators of gun violence are prohibited by federal law from purchasing firearms from a licensed dealer due to prior felony convictions or young age. Other contributions to this book provide compelling evidence that existing conditions for disqualifying someone from legally possessing firearms are justifiable and should be expanded (Vittes, Webster, and Vernick, in this volume). Wintemute (chap. 7 in this volume) and Zeoli and Frattaroli

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(in this volume) provide evidence that laws which prohibit firearm possession by persons convicted of violent misdemeanors and those who are subject to restraining orders for domestic violence can reduce violence.

Some prohibited persons will voluntarily refrain from having a firearm in order to avoid criminal sanctions. But policies that enhance firearm seller and purchaser accountability are likely to determine how effectively gun control laws prevent prohibited individuals from acquiring guns. The federal

passing a background check (Cook and Ludwig, in this volume). Licensed dealers must check purchasers' IDs, submit purchase applications to the FBI's National Instant Check System (NICS), and maintain records of all firearms acquisitions and sales so that ATF auditors can assess the dealers' compliance with gun sales laws.

Data on guns recovered by police and traced by the U.S. Bureau of Alcohol, Tobacco and Firearms (ATF) have indicated that about 85% of criminal possessors were not the retail purchaser (Bureau of Alcohol, Tobacco and Firearms 2002). This is consistent with our analysis of data from the most recent (2004) Survey of Inmates in State Correctional Facilities (SISCF) to determine the source for the handguns acquired by the 1,402 inmates incarcerated for an offense committed with a handgun. The largest proportions of offenders got their handguns from friends or family members (39.5%) or from street or black market suppliers (37.5%), sales for which there are no federal background check requirements. Licensed gun dealers were the direct source for 11.4% of the gun offenders. One in 10 offenders in our sample reported that they had stolen the handgun that they used in their most recent crime. Handgun acquisitions by offenders at gun shows and flea markets were rare (1.7%).

It is easy to understand why offenders would prefer private sellers over licensed firearms dealers. Under federal law and laws in most states, firearm purchases from unlicensed private sellers require no background check or record keeping. The lack of record keeping requirements helps to shield an offender from law enforcement scrutiny if the gun were used in a crime and recovered by police. Indeed, of the offenders in the SISCF who were not prohibited from possessing a handgun prior to the crime leading to their incarceration, two-thirds had obtained their handguns in a transaction with a private seller.

That only 11% of handgun offenders reported acquiring their handguns from a licensed gun dealer does not mean that licensed dealers play a negligible role in the diversion of guns to criminals. Federal gun trafficking investigations indicate that corrupt licensed dealers represent one of the largest channels for the illegal gun market (Bureau of Alcohol, Tobacco and Firearms 2000), and a national phone survey of gun dealers found a willingness to make gun sales likely to be illegal relatively common (Sorenson and Vittes 2003). As articulated by Vernick and Webster (in this volume) and Braga and Gagliardi (in this volume), current federal laws provide many protections to licensed firearm sellers, and the Bureau of Alcohol, Tobacco, Firearms and Explosives lacks the resources and political power to serve as a robust deterrent to illegal gun sales.

Prior Evidence That Better Regulation of Gun Sellers Reduces Diversions of Guns to Criminals

Weaknesses in federal gun sales laws may cause skepticism about whether gun control can work in the United States. However, states vary greatly in the nature of their gun sales laws. For example, many states extend conditions for firearm prohibitions beyond those covered in federal law to include additional high-risk groups and place additional regulations on firearm sales to prevent illegal transfers. Twelve states require retail firearm sellers to be licensed by state or local governments and allow law enforcement to conduct audit inspections of gun dealers (Vernick, Webster, and Bulzachelli 2006). Fifteen states extend firearms sales regulations to sales by private, unlicensed sellers, and two additional states require background checks for firearms sold at gun shows. Nine states have some form of licensing system for handgun purchasers, five require applicants to apply directly with a law enforcement agency and be photographed and fingerprinted, and three allow agencies to use their discretion to deny an application if they deem it to be in the interest of public safety. Additional laws enacted by states to keep guns from prohibited persons include mandatory reporting of loss or theft of private firearms, limiting handgun sales to one per person per month, and banning the sale of low-quality "junk guns" that are overrepresented in crime (Wintemute 1994; Wright, Wintemute, and Webster 2010).

A study which used crime gun trace data from 53 U.S. cities for the years 2000–2002 examined the association between state gun sales regulations and

the diversion of guns to criminals (Webster, Vernick, and Bulzacchelli 2009). Diversion of guns to criminals was measured by the number of guns recovered by police within one year of retail sale unless the criminal possessor was the legal retail purchaser. In addition to examining state laws, this study also surveyed state and local law enforcement officials to ascertain their policies for conducting compliance inspections or undercover stings of licensed dealers. Strong regulation and oversight of licensed gun dealers—defined as having a state law that required state or local licensing of retail firearm sellers, mandatory record keeping by those sellers, law enforcement access to records for inspection, regular inspections of gun dealers, and mandated reporting of theft or loss of firearms—was associated with 64% less diversion of guns to criminals by in-state gun dealers. Regulation of private handgun sales and discretionary permit-to-purchase (PTP) licensing were each independently associated with lower levels of diversion of guns sold by in-state dealers. The finding on private sales regulations is consistent with the results of a systematic observational study of gun sales at gun shows that found anonymous undocumented firearms sales to be ubiquitous and illegal “straw man” sales more than six times as common in states that do not regulate private sales compared with California that does regulate such sales (Wintemute 2007; Wintemute, chap. 7 in this volume).

Diversions of Guns to Criminals Following Missouri’s Repeal of Permit to Purchase Licensing

The associations between state gun sales laws and diversions of guns to criminals cited above are cross-sectional and therefore do not capture changes in gun diversions following changes in state gun sales laws. The strong association between at least some forms of PTP licensing and lower rates of gun diversions to criminals could potentially be confounded by some variable omitted from the analyses that distinguishes states that enact the most comprehensive firearm sales regulations from those that do not. There have been few noteworthy changes in gun sales laws during a period when crime gun tracking practices were more common and the data were available to track changes over time. An exception is the repeal of Missouri’s PTP law effective August 28, 2007. This law had required handgun purchasers to apply for a PTP through their local county sheriff’s office and required a PTP for all handgun sales, whether by licensed or unlicensed sellers. Following the repeal, handgun

purchasers could purchase handguns without a background check or record keeping if the seller was not a licensed dealer, and licensed gun dealers rather than sheriff's deputies processed applications to purchase handguns.

Using annual state-level data on crime guns recovered by police in Missouri and traced by the ATF for the period 2002–2011, we examined changes in commonly used indicators of illegal gun diversion—the number and proportion of guns with short sale-to-crime intervals—before and after the state repealed its PTP law. If Missouri's PTP law had been curtailing the diversion of guns to criminals, the repeal of the law should result in more short sale-to-crime guns recovered by police, and the shift in increasing crime guns should coincide with the length of time between the repeal of the law and a crime gun's recovery by police.

Such a pattern is clearly evident in the data presented in Table 8.1. The percentage of traced crime with a sale-to-crime interval of less than three months begins to increase from a pre-repeal stable mean of 2.8% to 5.0% in 2007 when the repeal was in effect for four months, and then jumps up to a mean of 8.5% for 2008 through 2011. The percentage of crime guns with sale-to-crime intervals of three to twelve months increased sharply beginning in 2008 from a pre-repeal mean of 6.2% to 14.0% for 2008–2011 when all such guns were purchased after the law's repeal. If the PTP repeal increased the diversion of guns to criminals, the percentage of crime guns recovered at a

Table 8.1 Percentage of Missouri Crime Guns with Short Time Intervals between Retail Sale and Recovery by Police for Years 2002–2011

Year	Up to 3 months (%)	3–12 months (%)	1–2 years (%)
2002	2.9	5.2	5.2
2003	3.2	5.3	6.1
2004	2.1	5.6	5.7
2005	3.3	5.1	6.6
2006	3.2	7.5	7.2
2007	4.5	7.9	7.1
2008	9.4	12.6	6.7
2009	8.1	15.0	12.7
2010	7.6	13.7	13.0
2011	8.5	14.3	12.7

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one to two years sale-to-crime interval should increase beginning in 2009. Indeed, that is what happened. These guns increased sharply from a mean of 6.4% to 13.0%. The sharp increase in very short sale-to-crime intervals for guns in Missouri was not part of a national trend; in fact, the average sale-to-crime interval increased nationally from 10.2 years in 2006 to 11.2 years in 2011.

Because states with stronger gun sales laws tend to attract guns originating in states with weaker gun laws (Cook and Braga 2001; Webster, Vernick, and Hepburn 2001), we also compared trends in the proportion of Missouri's crime guns that were initially purchased in Missouri versus those that had been purchased outside of the state. Consistent with our hypotheses that Missouri's PTP had been preventing guns from being diverted to criminals, the share of crime guns originating from Missouri increased from a mean of 55.6% when the PTP law was in place to 70.8% by 2011, while the proportion that had originated from out of state gun dealers decreased from 44.4% before the repeal, began dropping in 2008, and was 29.2% in 2011. This is a remarkable change for an indicator that tends to change very little over time.

Effects of State Gun Sales Laws on the Export of Guns to Criminals across State Borders

In 2009, 30% of crime guns traced by the ATF were recovered in states other than the state where they were originally sold; however, there is great variation across states with respect to the proportion of crime guns which were originally sold by gun dealers in other states. Mayors Against Illegal Guns (2010) published a report showing great disparities across states in the number of crime guns exported per capita. Bivariate analyses indicated that each of ten

versus weak gun laws and found that states with weak gun laws tended to export guns to states with strong gun laws (Knight 2011).

The present study adds to this literature by using crime gun trace data from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) to examine the cross-sectional association between state gun laws and the per capita rate of exporting crime guns across the 48 contiguous U.S. states. The following state gun sales laws were considered: strong regulations of retail

gun dealers¹; permit-to-purchase (PTP) licensing; private sales regulations (mandatory background checks of sellers or valid PTP); handgun registration; mandatory reporting to law enforcement of theft and loss of firearms by private owners; whether the state has criminal penalties for dealers who fail to conduct background checks or has penalties for illegal straw purchasers; one-gun-per-month restrictions; assault weapon bans; and junk gun bans. Three variations of PTP laws were examined: (1) discretionary PTP laws which give law enforcement the discretion to refuse to issue permits; (2) PTP with fingerprinting which requires applicants to appear at the law enforcement agency that issues the permits to be photographed and fingerprinted; and (3) nondiscretionary PTP laws which require a permit to purchase a firearm but do not require applicants to go to agencies to be fingerprinted.

We used negative binomial regression models with robust standard errors to estimate the association between state gun laws and the per capita rate of crime guns exported to criminals in other states after controlling for potential confounders. Key confounders controlled for in the analyses were the prevalence of gun ownership, out-of-state population migration, and the number of people living near the border of states with strong gun laws. State population served as an offset variable so that transformed regression coefficients could be interpreted as incident rate ratios (IRR) and percentage reductions in risk.

Data on crime gun exports were obtained from the 2009 state-level crime gun trace data posted on the ATF's website. ATF defines crime guns as recovered firearms that were "illegally possessed, used in a crime, or suspected to have been used in a crime." In 2009, 61% of the guns that police submitted to ATF were successfully traced to the first retail sale.

Data on state gun laws were obtained through legal research and from ATF and U.S. Department of Justice Publications. Oak Ridge National Laboratory's LandScan global population distribution data was used with arcGIS Version 10 to calculate state border population variables used as control variables in statistical models. These control variables included population within 50 miles of a bordering states with the strongest gun control laws² and states with medium level of gun control.³ Household prevalence of firearm ownership was obtained from the Behavioral Risk Factor Surveillance System 2001 survey (Centers for Disease Control and Prevention 2001), and measures of state migration⁴ were obtained from the American Community Survey (ACS) 2005–2009 five-year estimates. Finally, we measured two variables indicating that a state borders Canada or Mexico, respectively.

States that exported the most crime guns per 100,000 population were Mississippi (50.4), West Virginia (47.6), Kentucky (35.0), and Alabama (33.4). Of these four states, three (Mississippi, West Virginia, and Kentucky) had none of the state gun laws we examined. Alabama penalized gun dealers who failed to conduct background checks but had no other laws of interest in place. States that exported the fewest crime guns per capita—New York (2.7), New Jersey (2.8), Massachusetts (3.7), and California (5.4)—each had strong gun dealer oversight, regulated private sales, and handgun registries. New York, New Jersey, and Massachusetts also had discretionary PTP and required reporting of firearm theft/loss.

Data from the regression analysis are presented in Table 8.2. Due to high collinearity (Variance Inflation Factor > 10), assault weapons bans and handgun registration laws were dropped from the final models. Statistically significant lower per capita export of crime guns across state borders was found for

Table 8.2 Estimates of association between state gun laws and crime gun exports

	IRR	Robust SE	p value
State gun laws			
Discretionary purchase permits	0.24	0.10	.001
Purchase permits with fingerprinting	0.55	0.15	.02
Nondiscretionary permits	0.75	0.15	.15
Strong dealer regulation ^a	1.45	0.30	.07
Penalty for failure to conduct background checks	0.76	0.12	.07
Penalty for straw purchasers	1.46	0.30	.07
Junk guns banned	0.68	0.13	.04
Private sales regulated	0.71	0.11	.03
Firearm theft/loss reported	0.70	0.10	.02
One gun per month	0.81	0.26	.51
Covariates			
Household gun ownership	6.05	4.20	.009
Border population in states with strong gun laws ^b	1.00	1.82E-08	.50
Border population in states with medium gun laws ^c	1.00	2.57E-08	.14
Migration out of state	0.99	5.04E-07	.50
Borders Canada	0.68	0.065	<.001
Borders Mexico	0.84	0.19	.43

Note: IRR = incidence rate ratio. Model also includes state population offset term.

^aStates were considered to have strong dealer regulation if they require licensing of gun dealers, allow inspection of dealer records, and penalize dealers who falsify records.

^bStates were considered to have strong gun laws if they have a discretionary permit-to-purchase law.

^cStates were considered to have medium gun laws if they regulate private sales, require licensing of gun dealers, and allow inspections of dealer records.

discretionary PTP laws ($IRR = 0.24$, lowered risk 76%), nondiscretionary PTP laws requiring fingerprinting at a law enforcement agency ($IRR = 0.55$, -45%), junk gun bans ($IRR = 0.68$, -32%), regulation of private sales ($IRR = 0.71$, -29%), and required reporting of firearm theft or loss by private gun owners ($IRR = 0.70$, -30%) were each associated with statistically significantly lower rates of crime gun exports. Effects for penalties for gun dealers' failure to conduct background checks ($IRR = 0.76$) and penalties for straw purchases ($IRR = 1.24$) approached statistical significance at the .05 level but in opposite directions. Although billed as a deterrent to interstate gun trafficking, one-gun-per-month restrictions were unrelated to trafficking and neither were strong dealer regulations, penalties for failure to conduct background checks, or penalties for straw purchasing. Household gun ownership ($IRR = 6.05$) was associated with higher crime gun export rates and bordering Canada was associated with lower crime gun exports ($IRR = 0.84$). States bordering other states where gun laws are relatively strict was unrelated to the rate of exporting crime guns after controlling for gun sales laws and other factors.

Conclusions and Policy Implications

Data presented here provide compelling evidence that the repeal of Missouri's permit-to-purchase (PTP) law increased the diversion of guns to criminals. The timing of the effects on our indicator of diversion, short intervals between sales, and recovery in crime was in exact correspondence with the timing of the law's repeal. The changes observed in gun diversions in Missouri are likely related to the substantial change in how guns were sold following the law's repeal. Prospective purchasers of handguns being sold by private individuals no longer had to pass a background check and sellers were no longer required to document the sale. Prospective purchasers, including illegal straw purchasers, interested in buying handguns from licensed dealers applied to purchase the gun at the place that profited from the sale rather than at a law enforcement agency. Repealing the PTP law made it less risky for criminals, straw purchasers, and persons willing to sell guns to criminals and to their intermediaries, and these individuals appear to have taken advantage of the opportunities afforded to them by the repeal.

In our study of state gun sales laws in the 48 contiguous states, discretionary PTP laws were the most dramatic deterrent to interstate gun trafficking. This finding is consistent with prior research showing a negative association

between these laws and intrastate diversion of guns to criminals; however, the effects were either mediated by or explained by lower levels of gun ownership in states with these laws (Webster, Vernick, and Bulzachelli 2009). Discretionary permitting procedures such as in-depth and direct scrutiny by law enforcement, longer waiting times, higher fees, and stricter standards for legal ownership may depress gun ownership and reduce opportunities for criminals to find individuals who have guns that they would be willing to sell or who would be targets for gun theft. The strong negative association between nondiscretionary PTP laws and exporting guns to criminals in other states after statistically controlling for gun ownership levels, geography, and other gun laws suggests that PTP laws deter gun trafficking.

Perhaps most relevant to current debates about federal gun policy, we found that states which regulated all handgun sales by requiring background checks and record keeping, not just those made by licensed dealers, diverted significantly fewer guns to criminals in other states. This finding is consistent with the results of a prior study of intrastate diversions of guns to criminals (Webster, Vernick, and Bulzachelli 2009) and the findings of an observational study of sales practices gun shows (Wintemute 2007; chap. 7 in this volume). The importance of fixing this flaw in current gun law is highlighted by data first reported here which indicate that nearly 80% of handgun offenders incarcerated in state prisons reported purchasing or trading for their handgun from an unlicensed seller who, in most states, was not legally obligated to ensure that the purchaser passed a background check or to keep a record of the transaction.

Our examination of state firearms regulations and the interstate diversion of guns to criminals considered a larger array of laws than prior studies. Laws requiring private gun owners to promptly report theft or loss of firearms to police are intended to increase private gun seller accountability and provide law enforcement with a tool to combat illegal straw purchases when such purchasers accept no responsibility for the gun being in the hands of a prohibited person with dubious claims of unreported gun theft. Having this measure of accountability significantly reduced interstate gun trafficking, as did bans of junk guns. Junk guns are the least expensive guns, and their low price enables traffickers to invest relatively little money in guns that can sell for nearly five times more than retail prices on the streets in states with the most restrictive gun laws. Prior research on the effects of Maryland's ban of junk guns found the banned guns used much less in Baltimore, Maryland, than in cities with-

out such bans, seven years after Maryland's law was enacted (Vernick, Webster, and Hepburn 1999), and gun homicides were 9% lower than projected had the law not been enacted (Webster, Vernick, and Hepburn 2002).

Interestingly, a policy designed specifically to deter interstate gun trafficking—one-gun-per-month limits for gun buyers—was not associated with the export of guns to criminals in other states. Strong gun dealer regulations were also unrelated to exporting of crime guns across state lines. A prior study of intra-state trafficking found that strong dealer regulations by themselves were not effective unless law enforcement reported that they had a policy of regular compliance inspections. Unfortunately, we had no measure of enforcement for the current study.

Our assessment of the effects of state gun control laws on the export of guns to criminals in other states had several limitations. First, the cross-sectional study design precludes an assessment of whether changes in gun control laws prompt subsequent changes in crime gun exports. Longitudinal crime gun trace data could not be obtained, as many of the state laws of interest were in place before crime gun tracing became common practice. The sharp increase in diversions of guns to criminals following the repeal of Missouri's law, however, lessens this concern. Second, our outcome data does not include all crime gun exports. Not all crime guns are submitted to the ATF for tracing. In 2009, gun traces could not be completed for nearly 40% of crime guns due to insufficient or incorrect data. Third, although reducing the diversion of guns to criminals is a key objective of some gun control laws, there is currently insufficient research to discern the degree to which reductions in diverted guns affects gun violence, and it appears as though some have had no impact.

In spite of these limitations, our study is the first to estimate independent associations between a number of state gun control laws and crime gun export rates while controlling for confounders, and it is the first longitudinal assessment of the impact of permit-to-purchase licensing that regulates all handgun sales. Our findings on cross-state diversions of crime guns underscore the importance of having more comprehensive federal regulation of firearm sales because lax laws in many states facilitate the arming of criminals beyond state borders. At a minimum, federal law should require background checks and record keeping for all firearms sales. Regulating many private sellers is a challenge, yet the data suggest that it is necessary to deter the diversion of guns to criminals, and requiring gun owners to report theft or loss of firearms provides additional accountability to prevent illegal sales.

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ACKNOWLEDGMENTS

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NOTES

1. Licensing of gun dealers, inspection of dealer records allowed, and criminal penalties for dealers who falsified records.
2. PTP laws or in the District of Columbia with what could be considered a ban on firearm ownership until 2008.
3. Regulate private sales, require licensing of gun dealers, and allow inspections of dealer records.
4. The number of people who moved out of each state between 2005 and 2009.

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“The rate of firearms homicides in America is 20 times higher than it is in other economically advanced nations. We have got to change that.”
—From the Foreword by Michael R. Bloomberg, Mayor of New York City

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Selected recommendations include:

- **Background checks:** Establish a universal background check system for all persons purchasing a firearm from any seller.
- **High-risk individuals:** Expand the set of conditions that disqualify an individual from legally purchasing a firearm.
- **Mental health:** Focus federal restrictions on gun purchases by persons with serious mental illness on the dangerousness of the individual.
- **Trafficking and dealer licensing:** Appoint a permanent director to ATF and provide

the agency with the authority to develop a range of sanctions for gun dealers who violate gun sales or other laws.

- **Personalized guns:** Provide financial incentives to states to mandate childproof or personalized guns.
- **Assault weapons and high-capacity magazines:** Ban the future sale of assault weapons and the future sale and possession of large-capacity ammunition magazines.
- **Research funds:** Provide adequate federal funds to the Centers for Disease Control and Prevention, National Institutes of Health, and National Institute of Justice for research into the causes and solutions of gun violence.

The book includes an analysis of the constitutionality of many recommended policies and data from a national public opinion poll that reflect support among the majority of Americans—including gun owners—for stronger gun policies.

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Declaration Exhibit 4

Association Between Connecticut's Permit-to-Purchase Handgun Law and Homicides

Kara E. Rudolph, PhD, MPH, MHS, Elizabeth A. Stuart, PhD, Jon S. Vernick, JD, and Daniel W. Webster, ScD, MPH

Homicide was the second leading cause of death for individuals aged 15 to 34 years in the United States from 1999 to 2011¹ and the second leading contributor to racial disparities in premature mortality among men.² Firearms are used in more than two thirds of homicides in the United States,³ and firearm availability, especially to high-risk groups (e.g., perpetrators of domestic violence and violent misdemeanors),^{4,5} is positively associated with homicide risks.^{6,7}

Given the importance of firearms in lethal violence, many federal and state policies have been designed to prevent individuals with a history of violence, criminal behavior, substance abuse, or serious mental illness from accessing firearms. Federal law mandates that individuals who purchase firearms from federally licensed dealers pass a background check, but sales by private, unlicensed sellers are exempt. Eighteen states and the District of Columbia require handgun purchasers from private, unlicensed sellers to pass background checks. Ten of these states and the District of Columbia strengthen the background check requirement with a permit-to-purchase (PTP) law, although 4 do not require a new background check at the time of purchase.⁸ PTP laws require individuals to obtain a permit or license to purchase a handgun (from both licensed retail dealers and private sellers) that is contingent upon passing a background check and, in some cases, completing safety training. In 8 states, individuals must apply for a PTP in person at the law enforcement agency that initiates the background checks and issues permits. In the other 42 states, pre-gun-sale background checks are initiated through a licensed gun dealer, although there are significant differences among these policies. Table A (available as a supplement to this article at <http://www.ajph.org>) summarizes the status of these laws by state.

We conducted this study to estimate the impact of Connecticut's 1995 PTP law. This

Objectives. We sought to estimate the effect of Connecticut's implementation of a handgun permit-to-purchase law in October 1995 on subsequent homicides.

Methods. Using the synthetic control method, we compared Connecticut's homicide rates after the law's implementation to rates we would have expected had the law not been implemented. To estimate the counterfactual, we used longitudinal data from a weighted combination of comparison states identified based on the ability of their prelaw homicide trends and covariates to predict prelaw homicide trends in Connecticut.

Results. We estimated that the law was associated with a 40% reduction in Connecticut's firearm homicide rates during the first 10 years that the law was in place. By contrast, there was no evidence for a reduction in nonfirearm homicides.

Conclusions. Consistent with prior research, this study demonstrated that Connecticut's handgun permit-to-purchase law was associated with a subsequent reduction in homicide rates. As would be expected if the law drove the reduction, the policy's effects were only evident for homicides committed with firearms. (*Am J Public Health*. 2015;105:e49–e54. doi:10.2105/AJPH.2015.302703)

law strengthened background check requirements, especially for handguns purchased by private sellers. In addition, it raised the handgun purchasing age from 18 to 21 years and required any prospective handgun purchaser to apply for a permit in person with the local police and complete at least 8 hours of approved handgun safety training.

METHODS

To estimate the effect of Connecticut's PTP law on homicides, we compared Connecticut's homicide rates observed after the law's implementation to the rates we would have expected had the law not been implemented (the counterfactual). To estimate the counterfactual, we used longitudinal data from a weighted combination of comparison states with no PTP law change (henceforth, Connecticut's synthetic control) identified based on the ability of their prelaw homicide trends and covariates to predict prelaw homicide trends in Connecticut.

States that were considered as potential comparison states for Connecticut were those that did not have a PTP law in 1995 and

therefore were "at risk" for implementing a new PTP law in 1995. Ten states (Hawaii, Illinois, Iowa, Missouri, Massachusetts, Michigan, Nebraska, New Jersey, New York, and North Carolina) and the District of Columbia were excluded from the pool of possible controls because they implemented a PTP law prior to 1995. We used outcome and annual covariate data from Connecticut and each of the 39 states in the control pool from 1984 to 2005. We concluded the postlaw period in 2005 to limit counterfactual predictions to 10 years, as has been done previously.⁹

Outcomes

We examined 2 outcomes—firearm-specific homicide rates and non–firearm-specific homicide rates (number of homicides per 100 000 state residents)—obtained from compressed mortality data from the Centers for Disease Control and Prevention's Wide-ranging Online Data for Epidemiologic Research database (<http://wonder.cdc.gov/mortSQL.html>). We expected the impact of the PTP law—if any—to be limited to homicides committed with firearms.

Covariates

Annually measured state-level covariates and their sources follow. Population size, population density (log-transformed), proportion aged 0 to 18 years, proportion aged 15 to 24 years, proportion Black (log-transformed), proportion Hispanic (log-transformed), proportion aged 16 years or older living at or below poverty, and income inequality as measured by the Gini coefficient were from the US Census Bureau. Average per capita individual income and number of jobs per adult were from the Bureau of Economic Analysis. Proportion living in metropolitan statistical areas, law enforcement officers per 100 000 residents, and robberies per 100 000 residents were from the Federal Bureau of Investigation's Crime in the United States publications. The Census of Governments provided data on annual expenditures for law enforcement (current operation and capital outlay).

Statistical Analysis

We used the synthetic control group approach⁹ to create a weighted combination of states that exhibited homicide trends most similar to Connecticut's prior to the law's implementation (1984–1994). This weighted combination of states can be thought of as a "synthetic" Connecticut, whose homicide trends during the postlaw period predict the post-1995 trends that Connecticut would have experienced in the absence of the law change.

The algorithm for creating the weights has been described previously.⁹ The vector of weights minimized the mean squared prediction error (MSPE) between the homicide rates of Connecticut during the prelaw period and the weighted vector of outcomes and covariates of the control pool states during the prelaw period.⁹ No data from 1995 or thereafter were used in creating the weights and synthetic control.

After creating the weights using the Synth package in R,¹⁰ we compared homicide rates between Connecticut and its synthetic control in the 10 years after the PIP law was implemented (from 1996 to 2005). We excluded 1995 because the law was not implemented until October of that year. We excluded 2001 from the nonfirearm homicide analysis because of the large increase in deaths attributable to the 2001 terrorist attacks, which had

a disproportionate impact on Connecticut residents. The estimated number of homicides prevented by the law from 1996 to 2005 was calculated by multiplying the difference in homicide rates between Connecticut and its synthetic control by Connecticut's population size (in 100 000s) each year and summing across the years.

Statistical significance was assessed using a permutation-based test—also called a placebo or falsification test—that is similar to the Fisher exact test.^{9,11} For each outcome, we repeated the analysis where we considered each of the 39 states in the control pool as the "treated" state and created a synthetic control for each of these states. We calculated the proportion of control states with an estimated rate of prevented homicides that was as extreme as or more extreme than the estimated rate prevented for Connecticut. This proportion was akin to the *P* value and indicated how unusual Connecticut's estimated effect was compared with the states in the control pool.

However, not every control state's homicide trend can be well approximated by a synthetic control. Lack of fit was determined by greater MSPE, which is the average of the squared differences between homicide rates in the "treated" state and its synthetic control during the prelaw period. In cases of large MSPE, it is not appropriate to use the synthetic control as a comparison. Consequently, we calculated the proportions of control states with results as extreme or more extreme than Connecticut for 3 separate control pools, including control

states whose MSPE from their synthetic control was no more than (1) 20×, (2) 5×, and (3) 2× that of Connecticut's synthetic control MSPE. This entire analysis process was conducted twice: once for firearm homicides and once for nonfirearm homicides. We used R version 3.0.2 for all analyses.¹²

Sensitivity Analysis

In the data available as a supplement to the online version of this article, we considered an alternative approach in which we compared Connecticut's homicide rate trends to the 39 control states' average trends that were mean-shifted to the scale of Connecticut's homicide rates.

RESULTS

Using the predictive covariates as well as prelaw outcome data, we constructed a synthetic control for Connecticut for each of the 2 outcomes of interest. States with a nonzero weight contributed to the synthetic control and are listed in Table 1. Table 1 also shows how well the synthetic control approximated Connecticut's homicide rates during the prelaw period, as measured by MSPE. The last row of this table shows that the synthetic control was a better fit than a simple average of all the states in the control pool. For example, in the case of firearm homicides, the synthetic control had an MSPE of 0.157, which is an order of magnitude less than the MSPE if a simple average of all control states had been used.

TABLE 1—States With Nonzero Weights In the Synthetic Connecticut for Firearm and Nonfirearm Homicide Rates: 1996–2005

State	Weight	
	Firearm Homicides	Nonfirearm Homicides
California	0.036	0.000
Maryland	0.147	0.110
Nevada	0.087	0.121
New Hampshire	0.005	0.724
Rhode Island	0.724	0.046
MSPE synthetic control/all control states	0.157/1.633	0.090/0.740

Note. MSPE = mean squared prediction error. Thirty-nine states were included in the pool of possible controls. Ten states with a similar law implemented prior to 1995 were not included: Hawaii, Illinois, Iowa, Missouri, Massachusetts, Michigan, Nebraska, New Jersey, New York, and North Carolina.

Table B (available as a supplement to this article at <http://www.ajph.org>) shows descriptive statistics for each of the covariates found to be predictive of homicide rates during the prelaw period. These variable summaries are provided for Connecticut, the pool of control states, and Connecticut's synthetic control optimized for (1) firearm and (2) nonfirearm homicides.

Figures 1 and 2 compare firearm and nonfirearm homicide rates over time between Connecticut and its synthetic control. The average homicide rates over the study period for all states in the control pool are included for reference. Figure 1 shows that firearm homicide rates for Connecticut and its synthetic control tracked together prior to the law's implementation in October 1995; this is also evidenced by the low MSPE shown in Table 1. However, beginning in 1999, the rates diverged markedly. Connecticut's firearm homicide rate continued to decline before leveling off in the early 2000s, whereas its synthetic

control's firearm homicide rate leveled off approximately 5 years earlier. Summing the differences between Connecticut and its synthetic control from 1996 to 2005, we estimated the law to be associated with 296 fewer firearm homicides during this period, a reduction of 40% relative to the counterfactual.

The permutation tests were consistent with this graphical intuition and indicated that Connecticut's divergent firearm homicide trend during the postlaw period was statistically significant. None of the 30 potential control states with an MSPE no more than 5× that of Connecticut's had firearm homicide trends that diverged as widely from their synthetic controls as Connecticut's did (Table 2).

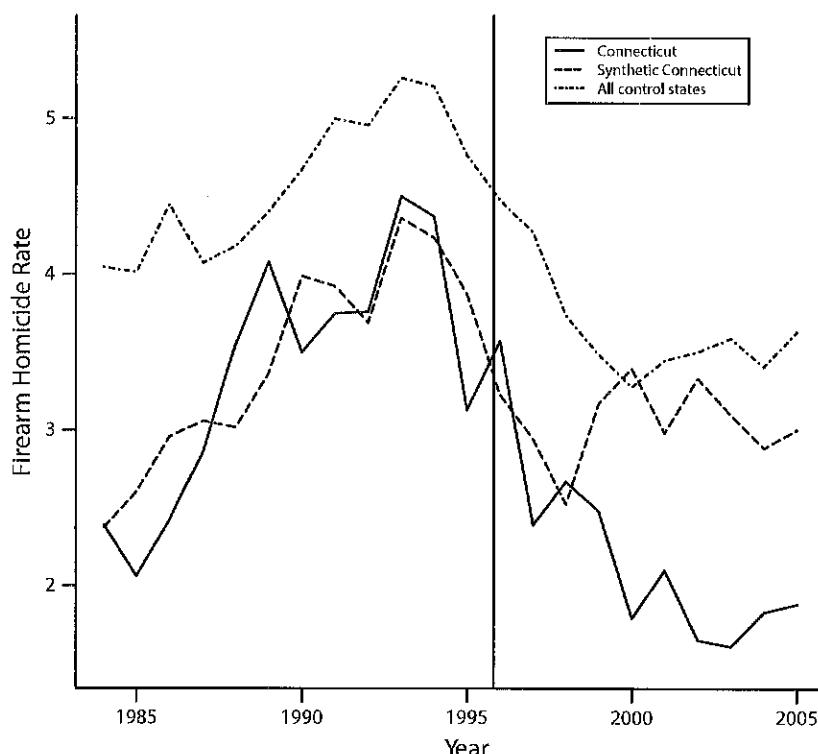
Figure 2 shows nonfirearm homicide rates in Connecticut compared with its synthetic control and with all states in the control pool. Connecticut's nonfirearm homicide rate trend tracked closely with that of its synthetic control's prior to the PTP law's implementation. However, the nonfirearm homicide rates for

Connecticut and its synthetic control did not diverge following the law's implementation. Summing the differences between Connecticut and its synthetic control from 1996 to 2005, we estimated that the law was associated with 24 fewer nonfirearm homicides during this period than expected. The permutation tests indicated that any divergence between Connecticut's nonfirearm homicide rates and those of its synthetic control during the postlaw period was not statistically significant (Table 2).

DISCUSSION

Previous studies have suggested that PTP laws may prevent the diversion of guns to criminals,¹³⁻¹⁵ and the sharp increase in gun homicides after Missouri's PTP law was repealed suggests that PTP laws may reduce lethal violence.¹⁶ Consistent with these previous studies, this study demonstrated that Connecticut's PTP law was associated with a subsequent reduction in homicide rates. As would be expected if the PTP law drove the reduction, the effects were only seen for homicides committed with firearms.

Connecticut's firearm homicide rate trend departed from its synthetic control from 1999 to 2005. This lag between the law's implementation and divergence in homicide trend may call into question whether the estimated effect resulted from the PTP law or from unmeasured interventions enacted in 1999 that only selectively reduced firearm homicides. However, there are plausible explanations for a delayed policy effect. First, spikes in gun sales may occur just prior to a significant gun control law, perhaps because of media scrutiny, and the additional guns sold under less rigorous regulation could temporarily counteract the law's preventive effects.^{17,18} Second, the number of transactions blocked by the PTP law may accumulate over time until gun availability in the underground market is sufficiently constrained to appreciatively affect handgun acquisition. The net effect of these 2 opposing forces—prelaw sales uptick and postlaw downturn—may result in no immediate effect but fewer high-risk gun acquisitions several years after implementation. Such a delayed effect was observed following Maryland's ban of small, poorly constructed handguns that were overrepresented in crime.¹⁸



Note. Connecticut (solid line) compared with synthetic Connecticut (dashed line) and all states in the control pool, equally weighted (dotted line). The vertical line indicates when Connecticut's permit-to-purchase law was implemented.

FIGURE 1—Firearm homicide rates: Connecticut, 1996–2005.



Note. Connecticut (solid line) compared with synthetic Connecticut (dashed line) and all states in the control pool, equally weighted (dotted line). The vertical line indicates when Connecticut's permit-to-purchase law was implemented. Rates for 2001 are not included because of the World Trade Center attacks.

FIGURE 2—Nonfirearm homicide rates: Connecticut, 1996–2005.

It is plausible that Connecticut's PTP law could reduce firearm homicide rates as substantially as the 40% reduction estimated. The PTP law (1) strengthened background check requirements for handguns sold by private sellers and licensed firearm dealers, (2) required completion of an approved handgun safety course of at least 8 hours, and (3) increased the minimum legal age for handgun purchase from 18 to 21 years, blocking an age group with a high homicide offending rate.¹⁹ Since 1965, Connecticut law has required private handgun sellers to mail a form to local police with information on prospective handgun purchasers to allow for—but not mandate—a background check with a 1-week waiting period. Local authorities with knowledge of a prospective purchaser's ineligibility to possess a handgun were required to notify the seller. This law was strengthened in October 1994 to require local law enforcement to "make a reasonable effort" to determine whether an applicant was ineligible to own a handgun

(Connecticut Public Act No. 94-1 [July Special Session 1994], Section 1[b]); in October 1995, it was further strengthened by the PTP law, which requires prospective handgun purchasers to obtain an eligibility certificate through their local police department. The implementation of the PTP law also changed the process for purchasing handguns from licensed firearm dealers—previously, handgun purchasers could apply for a permit directly from a gun shop. After the PTP law, if the applicant passed a background check and showed proof of successful completion of an approved handgun safety course, then a permit was issued that would be valid for 5 years. Requiring application in person at the police department as well as the safety course may dissuade potential straw purchasers (those who buy guns for prohibited persons) or others considering purchasing handguns to commit a crime.

The law's protective effects against homicides may be mediated by reductions in the

diversion of guns to criminals. These diversions are indirectly measured from traces of guns recovered by police such as crime guns that come across state borders and have short sale-to-crime intervals.²⁰ Unfortunately, reliable crime gun trace data do not extend to the prelaw period, so we could not test this hypothesis. Current crime gun trace indicators suggest that Connecticut is performing better than the national average in terms of gun diversions. The average sale-to-crime interval for guns recovered by police in Connecticut is more than 2.5 years longer than the national average.²¹ Almost half of the guns recovered by police in Connecticut originated from retail sales in other states, approximately 15% higher than the national average.²¹

Estimating state law effects requires estimating the counterfactual—the outcome had the law not been implemented but all else remained equal. This is typically done by comparing outcomes over time between states with the law and states without the law. The synthetic control method used in this study was appropriate for the comparative case study design and was related to the difference-in-differences approach to estimating intervention effects.⁹ This method has gained popularity recently in estimating economic and health policy effects.^{9,22–25} The advantages of this approach and its assumptions have been discussed previously.²⁶

The first assumption of the synthetic control approach is that there were no interruptions in the law and no effects prior to its implementation. There was no evidence that the law's implementation was interrupted. However, as

TABLE 2—Proportion of Control States With Results as Extreme as or More Extreme Than Connecticut: 1996–2005

Control States Included ^a	Firearm	Nonfirearm
≤ 20× MSPE	3/38	13/39
≤ 5× MSPE	0/30	11/32
≤ 2× MSPE	0/24	8/26

Note. MSPE = mean squared prediction error.

^aResults from permutation tests including control states whose synthetic control's MSPE is ≤ 20×, 5×, and 2× that of the MSPE of Connecticut's synthetic control.

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stated previously, it is plausible that more handguns were purchased just prior to the PTP law's implementation.

The second assumption is that the implementation of the PTP law has no effect on other states' homicide rates. If this assumption was violated in this study, there is no appealing strategy for relaxing it. One approach would be to restrict the analysis to states that are not geographically close to Connecticut. The drawback of this strategy is that states such as Rhode Island and New Hampshire, which were large contributors to Connecticut's synthetic control, would be excluded.

The third assumption is that there are no unmeasured confounders during the postlaw period. This is a concern in any study with nonrandom assignment to intervention status. However, the synthetic control provided a good fit to Connecticut's homicide rates during the prelaw period, and intrastate correlation of homicide rates from 1984 to 2005 was very high, ranging from 0.84 to 0.97. Thus, a synthetic control that fits well during the prelaw period is likely to provide a good fit during the postlaw period as well.

Connecticut passed 2 gun laws of note in the poststudy period. In 1998, Connecticut began prohibiting firearm possession for persons who committed serious offenses adjudicated in juvenile courts. However, this condition affected a very small segment of gun offenders who were not already prohibited, and there is no evidence that these policies affected homicide rates.²⁷ In 1999, Connecticut began requiring background checks for private transfers of long guns. However, long guns accounted for a small percentage of the firearms used in murders in Connecticut during the study period prior to 1999.²⁸

Rhode Island, which contributed most to the firearm homicide synthetic control (72%), did not adopt a significant gun law during the postlaw study period. Maryland, which accounted for 14% of the firearm homicide synthetic control, implemented a law in October 1996 that required background checks for all handgun transfers. This law, in addition to a 1990 ban of "junk guns," may have reduced firearm homicides in Maryland.¹⁸ California contributed less than 5% of the firearm homicide synthetic control and was active in adopting stricter gun control laws throughout the study period, the most significant of which

were comprehensive background checks for handgun transfers and 10-year firearm prohibitions for violent misdemeanants. Both were implemented in 1991. Any protective effects of firearm laws in Maryland and California that were realized after 1995 may have biased our estimates of the impact of Connecticut's PTP law on firearm homicide rates toward the null. Successful interventions in major jurisdictions in the states included in the synthetic control could have confounded our estimates. However, we are unaware of any intervention that affected firearm homicides enough to have affected statewide rates over a 7-year period.

Fixed effects regression models are a common way of estimating the effects of state laws while also controlling for variables that may have potentially confounded this estimate. We believed this approach to be inappropriate in this case for several reasons. First, it relied on questionable assumptions that all states and time periods could have implemented a PTP law and that the association between PTP law implementation and homicide rates would be the same for all states. We had very little data with which to evaluate these assumptions, because only one other state implemented a PTP law during the study period. (Nebraska implemented a PTP law in 1991 that differed in important ways from Connecticut's.) In addition, fixed effects regression models failed to recognize the comparative case study design of both the data and research question and would have inappropriately extrapolated the effect estimated for Connecticut to the pool of control states.

The goal of this study was to estimate the effect of Connecticut's PTP law on homicides in Connecticut—not to extrapolate the effect of Connecticut's law on homicides to an average control state. The synthetic control approach allowed us to estimate such an effect and appropriately restricted the interpretation to the state of Connecticut. In addition, the method of assessing significance of the estimated results was more appropriate than a large-sample inferential technique, such as regression, given the small number of units.⁹ Other advantages of this method over standard regression methods included (1) the data-driven estimation of policy effects (through the synthetic control weights) to produce the most accurate counterfactual and (2) the

incorporation of both graphical and numerical checks (through the MSPE) of how well the comparison approximated the case.

Examining the extent to which stronger background check policies affect suicide rates is an area for future work. Previous research suggests that states with stricter gun permitting and licensing regulations have lower suicide rates.²⁹ This research should be corroborated with studies that use longitudinal data to examine changes in PTP laws and subsequent changes in firearm suicide rates.

This study has important policy implications as lawmakers consider options for reducing gun violence. Connecticut's PTP law seems to reduce firearm-specific homicides. Following the process in place in 6 states now, the most recent federal legislation considered by Congress to require background checks for many private party transactions would require prospective purchasers to go to a federally licensed gun dealer who would process the purchase application and submit the information for the background check. Future research should compare the effectiveness of this approach versus the approach used in PTP laws. Other unexamined issues include standards of evidence to hold noncompliant gun sellers accountable and the significance of penalties for failing to comply with gun sales laws. ■

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Contributors

K. E. Rudolph contributed to the study design and interpretation of results and led the analysis, drafting, and revision of the article. E. A. Stuart contributed to the study design, analysis, interpretation of results, and article revisions. J. S. Vernick contributed to obtaining the data, interpreting the results, and revising the article. D. W. Webster conceptualized the study and contributed to obtaining the data, interpreting the results, and drafting and revising the article.

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Human Participant Protection

This study was determined not to be human participant research by the institutional review board at the Johns Hopkins Bloomberg School of Public Health.

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Declaration Exhibit 5

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Effects of the Repeal of Missouri's Handgun Purchaser Licensing Law on Homicides

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Jon S. Vernick

ABSTRACT *In the USA, homicide is a leading cause of death for young males and a major cause of racial disparities in life expectancy for men. There are intense debate and little rigorous research on the effects of firearm sales regulation on homicides. This study estimates the impact of Missouri's 2007 repeal of its permit-to-purchase (PTP) handgun law on states' homicide rates and controls for changes in poverty, unemployment, crime, incarceration, policing levels, and other policies that could potentially affect homicides. Using death certificate data available through 2010, the repeal of Missouri's PTP law was associated with an increase in annual firearm homicides rates of 1.09 per 100,000 (+23 %) but was unrelated to changes in non-firearm homicide rates. Using Uniform Crime Reporting data from police through 2012, the law's repeal was associated with increased annual murders rates of 0.93 per 100,000 (+16 %). These estimated effects translate to increases of between 55 and 63 homicides per year in Missouri.*

KEYWORDS *firearm policy, firearm violence, gun policy, gun violence*

INTRODUCTION

Homicide is the second leading cause of death for people aged 15–34 years in the USA and the leading cause of death for black males in this age group.¹ Homicide also accounts for 5 % of the Years of Potential Life Lost (YPLL) in the USA² and is the second leading cause of the racial disparity in life expectancy between black and white males.³ Two-thirds of all homicides in the USA are committed with firearms,¹ and the firearm homicide rate in the USA is 19.5 times higher than the average firearm homicide rate in other high-income countries.⁴

It has been argued that weaknesses in federal and state firearms laws contribute to the unusually high homicide rate in the USA, especially the lack of background checks or record-keeping requirements for private, unlicensed sellers of firearms.⁵ Many perpetrators of homicide have backgrounds that would prohibit them from possessing firearms as a result of prior convictions for felony crimes⁶ or for misdemeanors involving domestic violence, being under a restraining order for domestic violence, young age, or other disqualifications.⁷ Federal law requires background checks and record keeping for sales by federally licensed firearms

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dealers but exempts these regulations when the firearm seller is unlicensed. Fifteen states require individuals purchasing handguns from unlicensed sellers to pass background checks, and eleven of these states require all handgun purchasers to acquire a permit-to-purchase (PTP) license.

PTP systems require prospective handgun purchasers to obtain a license verifying that they have passed a background check. All handgun sellers, both licensed dealers and private sellers, may only sell to those with a current PTP license. Most states with PTP handgun licensing require applicants to apply for the license directly at a law enforcement agency. In all other states, individuals wishing to purchase a handgun from a licensed dealer must complete a purchase application form. The dealer or dealer's employee submits the form to the Federal Bureau of Investigation's (FBI) National Instant Check System (NICS) or, in some cases, to state police, to determine whether the applicant is prohibited from possessing firearms.

Prior research has shown that cities and states that require background checks and record keeping for handgun sales by unlicensed sellers and stricter PTP handgun licensing laws have lower levels of guns being diverted to criminals within a year of retail sale⁸ and fewer guns exported to criminals across state borders.⁹ A recent study found a cross-sectional association between states having PTP handgun licensing or other forms of universal background check requirements for gun sales and lower homicide rates.¹⁰

Missouri repealed its PTP handgun licensing law effective August 28, 2007. Missouri's law had been in place since 1921 and required all handgun purchasers to have a valid PTP license (good for 30 days) in order to lawfully purchase a handgun from any seller, licensed or unlicensed. Applicants applied in person at their local sheriff's office which facilitated the background check. Webster and colleagues³ reported that immediately following the repeal of Missouri's PTP handgun law, there was a twofold increase in the percentage of guns that had unusually short intervals between the retail sale and the recovery by police, an indicator of firearm diversion or trafficking.^{11, 12} The repeal also coincided with a sharp increase in the percentage of crime guns recovered by police in Missouri that had been originally sold by in-state retailers, from 56.4 % in 2006 to 71.8 % in 2012.¹³

This study examines the effects of the repeal of Missouri's PTP handgun licensing law on homicide rates. Because this change eliminated mandatory background checks for handguns sold by unlicensed sellers, it is of particular relevance for debates in the US Congress and in several states about proposals to extend background check requirements to all firearm sales.

METHODS

Design

The association between the repeal of Missouri's PTP handgun licensing law on homicide rates was estimated using a quasi-experimental research design with annual, state-level homicide rates. Homicide rates were age adjusted and stratified by those committed with a firearm versus all other methods to discern the specificity of the effects of the policy change on firearm versus non-firearm homicides.

Data and Measures

We hypothesized that the policy change would affect homicide rates but only those committed with firearms. Thus, the primary outcome measure was state-level annual

firearm homicide rates, derived from death certificate and census data, age adjusted (reference year 2000) in Centers for Disease Control and Prevention's (CDC) Web-based Injury Statistics Query and Reporting System (WISQARS) Fatal Injury Reports.¹⁴ Seven states (HI, ME, NH, ND, SD, VT, and WY) were dropped from the analyses because WISQARS suppressed the data for states and years for which there were very few firearm homicides to protect the anonymity of the data. Missouri's mean baseline rate of firearm homicides during the pre-repeal study years was approximately four to five times higher than was experienced in the seven dropped states, and none of the dropped states were geographically close to Missouri. Within Missouri, we also used county-level cause-of-death mortality data from CDC's Wide-ranging Online Data for Epidemiologic Research (WONDER) system¹⁵ to assess the degree to which state-wide changes in age-adjusted homicide rates differed across counties.

These data from CDC's WISQARS and WONDER systems have the advantage of complete, mandatory reporting of death certificate data and the ability to easily isolate homicides committed with firearms versus other methods. The disadvantage of these data is that they were only available through the end of 2010 at the time of this study. We also collected and analyzed state-level data on annual rates of murder and non-negligent manslaughter (which will capture virtually all homicides) from the Federal Bureau of Investigation's (FBI) Uniform Crime Reporting (UCR) system. UCR data provided two additional years of post-PTP-law-repeal data; however, the FBI has to interpolate some data for states and years, when there is incomplete reporting from local law enforcement agencies, and rates are not age adjusted.

Although data from prior years are available, we chose 1999 as the beginning of our study period because the period 1999–2012 has been the most stable period for homicide trends in many decades. Periods of dramatic change, especially if the underlying causes for those changes cannot be easily modeled, are vulnerable to omitted variable bias in estimates of policy impact.¹⁶

Regression analyses are used to estimate policy change effects and controlled for changes in rates of unemployment, poverty, incarceration, burglary, law enforcement officers per capita, and the presence of four other types of state laws potentially most directly relevant to lethal violence for which there was significant change during the study period. These laws included so-called Stand Your Ground (SYG) laws, which give individuals an expanded right to use deadly force in potentially dangerous encounters with no duty to retreat, right-to-carry (RTC) laws which require law enforcement agencies to issue permits to carry concealed firearms to all legally qualified applicants, bans of unsafe handguns including so-called Saturday Night Specials, and firearm prohibitions for young adults resulting from convictions for serious crimes adjudicated in juvenile courts. SYG laws have been enacted in many states in recent years, including in Missouri in 2007. Prior research indicated that these laws may increase homicides.¹⁷ Early research suggested that RTC laws may reduce homicides,¹⁸ but the most rigorous studies show no evidence that RTC laws affect homicide rates.^{19, 20} Maryland's adoption of a SNS ban was associated with a reduction in firearm homicide rates,²¹ but this policy has not been rigorously studied in other states nor has firearm prohibitions stemming from serious juvenile offenses.

Average annual unemployment rates (per 100 population 16 years of age and older) were obtained from the Bureau of Labor Statistics.²² Poverty rates (per 100 population) were obtained from the Census Bureau's Current Population Survey.²³ Burglary rates (per 100,000 population)—an indicator of crime rates that should not

be directly affected by gun laws—and the rates of law enforcement officers (per 100,000 population) were drawn from the FBI's UCR program.²⁴ Incarceration rates (per 100,000 population) are from the Sourcebook of Criminal Justice Statistics.²⁵ The repeal of Missouri's PTP handgun licensing law was measured as the proportion of days in a year when the state had no PTP handgun law, i.e., 0 for the years the PTP law was in place (1999–2006), 0.263 in 2007, and 1 for 2008–2012.

Analytic Methods

Pre-repeal versus post-repeal differences in mean age-adjusted homicide rates were tested for statistical significance using *t*-tests. To estimate the independent association between the repeal of Missouri's PTP handgun licensing law and age-adjusted homicide rates, we used generalized least squares regression models. The models included state- and year-fixed effects to control for baseline differences in states' homicide rates and yearly fluctuations that occurred nationally as well as changes in the covariates described above. Standard errors for model coefficients were adjusted to account for clustering by state and for heteroskedasticity using the Eikert–Huber–White adjustment.²⁶ Analyses were conducted using Stata IC v 11.0.²⁷

RESULTS

From 1999 to 2007, Missouri's firearm homicide rate was relatively stable, fluctuating around a mean of 4.66 per 100,000 population per year (Fig. 1). In 2008, at the first full year after the permit-to-purchase licensing law was repealed, the firearm homicide rate in Missouri increased sharply to 6.23 per 100,000, a 34 % increase from the baseline mean. For the post-repeal period of 2008–2010, the mean annual firearm homicide rate was 5.82, 24.9 % higher than the pre-repeal mean ($t=4.38$, $df=10$, $p=.001$). Within Missouri, firearm homicide rates per 100,000 increased sharply between the pre- and post-repeal periods in each of the three large central metro counties/jurisdictions—by 30 % in Jackson County (11.2 to 14.7), 47 % in St. Louis County (5.0 to 7.4), 27 % in St. Louis City (21.7 to 27.5),

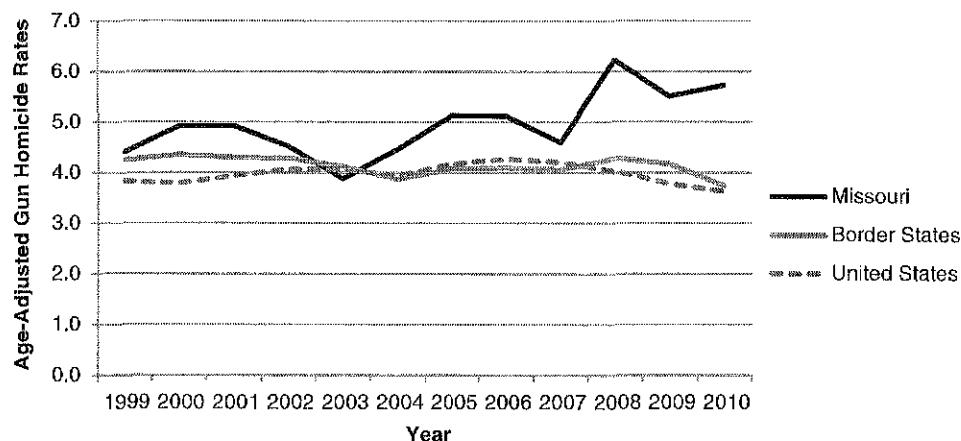


FIG. 1 Age-adjusted firearm homicide rates in Missouri, states bordering Missouri (population-weighted averages), and the USA, 1999–2010.

and 34 % overall in the nine Missouri counties designated as large metropolitan fringe counties (3.1 to 4.2).

This sharp increase in firearm homicide rates in Missouri beginning in 2008 was out of sync with changes during that period nationally and in states bordering Missouri (Table 1). The mean age-adjusted firearm homicide rate in the USA declined 5.5 % from 4.03 per 100,000 during 1999–2007 to 3.81 for 2008–2010. The population-weighted mean firearm homicide rates across the eight states bordering Missouri changed little between these two time periods (4.15 to 4.06, -2.2 %; $p=.480$, Fig. 1), and there were no statistically significant changes in any specific state that bordered Missouri.

Controlling only for baseline differences across states and year effects nationally (model 1, Table 2), the repeal of Missouri's PTP handgun licensing law was associated with an increase in firearm homicide rates of 1.32 per 100,000 ($p<.001$), a 29.4 % increase above rates projected without the repeal. After controlling for changes in rates of unemployment, poverty, burglary, incarceration, and law enforcement officers along with other state laws, the estimated increase in annual firearm homicide rates associated with the repeal of Missouri's PTP handgun law was 1.09 per 100,000 population per year ($p<.001$; 95 % confidence interval (CI) 0.81 to 1.38), a 2.3 % increase.

The increase in homicide rates following the repeal of Missouri's PTP handgun licensing law occurred only for homicides committed with firearms. Following similar trends nationally, Missouri's age-adjusted rate of non-firearm homicides declined from a pre-repeal (1999 to 2007) mean of 2.19 to a post-repeal (2008 to 2010) mean of 1.88 (-14 %). Regression analyses indicated that Missouri's repeal of its PTP handgun law was associated with no change in the age-adjusted non-firearm homicide rate ($\beta=-0.077$, $p=.446$) and an increase in annual homicide rates for all methods of 1.00 per 100,000 (Table 2, $p<.001$, 95 % CI 0.66 to 1.35).

TABLE 1 Mean firearm homicide rates before (1999–2007) and after Missouri repealed its permit-to-purchase handgun licensing requirement for handgun sales by licensed and unlicensed sellers (2008–2010)

	Mean before Missouri's PTP handgun law repealed 1999–2007	Mean after Missouri's PTP handgun law repealed 2008–2010	% Change	Probability 2 means are equal
Missouri	4.67	5.82	+24.9	.001
Population-weighted mean for states bordering Missouri	4.15	4.06	-2.2	.480
Arkansas	5.12	5.23	+2.1	.691
Illinois	5.10	4.77	-6.6	.335
Iowa	0.93	1.00	+7.8	.627
Kansas	3.95	3.85	-3.4	.757
Kentucky	3.26	3.29	+1.0	.898
Nebraska	1.75	2.28	+30.0	.096
Oklahoma	3.80	3.93	+3.5	.618
Tennessee	5.42	5.23	-3.5	.553

TABLE 2 Estimates of effect of the repeal of Missouri's permit-to-purchase handgun law from generalized least squares regression models on states' age-adjusted firearm, non-firearm, and all-cause homicide rates, 1999–2010, and murder and non-negligent manslaughter rates, 1999–2012

Outcome variable	β	Robust S.E.	P value	95 % CI for β
Firearm homicide rates, 1999–2010 R^2 within=.208, R^2 overall=.948	1.09	0.14	<.001	0.81 to 1.38
Non-firearm homicide rates, 1999–2010 R^2 within=.162, R^2 overall=.583	-0.08	0.10	.446	-0.28 to 0.12
Total homicide rates, 1999–2010 R^2 within=.177, R^2 overall=.943	1.00	0.18	<.001	0.66 to 1.35
Murder and non-negligent manslaughter rates, 1999–2012 R^2 within=.183, R^2 overall=.908	0.93	0.23	<.001	0.48 to 1.38

All models controlled for rates of unemployment, poverty, burglary, incarceration, law enforcement officers, "Stand Your Ground" laws, right-to-carry laws, bans of Saturday night special (junk) handguns, and firearm prohibitions of young adults with prior serious criminal offenses adjudicated in juvenile courts. Estimates for each of these covariates can be found in the Supplemental Tables.

Using UCR data from police reports for 1999–2012, the difference in the annual murder rate in Missouri minus that of the U.S. as a whole grew from 0.60 per 100,000 population during the pre-PTP-repeal period to 1.82 during the 5 years after the repeal of the PTP law (data not shown, $t=4.12$, $df=12$, $p<.001$). A model which only controlled for state- and year-fixed effects estimated a 1.34 increase in annual murder rates associated with the repeal of the PTP handgun law ($\beta=1.34$, $p=.001$, 95 % CI 0.58 to 2.11); however, the estimated effect of the policy change was reduced to an increase of 0.93 murders per 100,000 population per year after all covariates were included in the model (Table 2, $\beta=0.93$, $p<.001$, 95 % CI 0.48 to 1.38), a 16 % increase relative to the counterfactual.

Firearm homicide, total homicide, and murder rates were positively associated with burglary rates and negatively associated with poverty rates. New unsafe handgun bans adopted in California and Massachusetts were associated with an increase in total homicide rates ($\beta=0.46$, $p=.008$, 95 % CI 0.12 to 0.80). No other covariate reached statistical significance at the .05 level (Supplemental Tables).

DISCUSSION

This study provides compelling evidence that the repeal of Missouri's PTP handgun licensing law, which required all handgun purchasers to pass a background check even for purchases from private sellers, contributed to a sharp increase in Missouri's homicide rate. Our estimates suggest that the law was associated with an additional 55 to 63 murders per year in Missouri between 2008 and 2012 than would have been forecasted had the PTP handgun law not been repealed.

Our analyses ruled out several alternative hypotheses to explain the relatively large and highly statistically significant increase in firearm homicides in Missouri following the repeal of its PTP handgun licensing law. We controlled for changes in unemployment, poverty, policing levels, incarceration rates, trends in crime reflected in burglary rates, national trends in homicide rates, and several kinds of other laws

that could affect homicides. That Missouri's sharp increase in firearm homicides was unique within the region, specific to firearms, and was observed in metropolitan jurisdictions across Missouri suggests that unmeasured unique local circumstances (e.g., gang activity and changes in social norms) are unlikely to have biased our estimates of the impact of the policy change. Estimates of the effects of the repeal of Missouri's PTP handgun law were similar for firearm homicides and total homicides using death certificate data for 43 states through 2010, and for murders and non-negligent manslaughters using police reports for all 50 states through 2012. This suggests that the data source and time period studied are unlikely to have biased the findings.

Causal inferences from quasi-experimental studies can be strengthened with empirical evidence supporting the proposed causal chain between the intervention, mediators, and the outcomes under study. Handgun purchaser licensing and universal background checks are hypothesized to affect homicide rates by reducing gun diversions to criminals and other prohibited groups. The evidence that Missouri's increase in firearm homicides was fueled by the state's repeal of its PTP law is bolstered by data indicating that the repeal was immediately followed by a twofold increase in the percentage of crime guns that were recovered by police soon after the guns' retail sales and an unusually large increase in the percentage of Missouri's crime guns that had been purchased from Missouri gun dealers.⁶ These findings are consistent with prior research showing that states that regulated handgun sales by unlicensed sellers had fewer guns diverted to criminals shortly after in-state retail sales,⁸ and that states with the most comprehensive handgun sales laws including PTP licensing requiring direct interface with law enforcement have proportionately fewer guns used in crime that were originally sold by in-state retailers.^{28, 29} Having a large percentage of crime guns that originate from out-of-state sales, as was the case in Missouri prior to the repeal of its PTP law, is indicative of a restricted supply of guns available to criminals from in-state sources. Restrictions from local suppliers increase prices in the underground gun market and attract suppliers from states with fewer legal impediments to gun diversion.^{30, 31}

The weakening of Missouri's gun laws may have also contributed to gun trafficking to border states that regulate handgun sales by all sellers via PTP licensing. The number of guns sold in Missouri and later recovered by police in Illinois and Iowa, two border states with handgun purchaser licensing laws, increased 37 % (from 133 to 182) from 2006 (just before Missouri's PTP law was repealed) to 2012 when the overall number of crime guns recovered by police in those states actually declined by 6 %.¹²

A potential threat to the validity of our estimate of the impact of the repeal of Missouri's PTP law is confounding by the simultaneous adoption of a Stand Your Ground law in Missouri. Controlling for the effects of SYG laws across all states, our estimate of the effect of the repeal of Missouri's PTP law on homicide rates declined slightly but was still substantial and statistically significant at $p < .001$. A separate analysis of justifiable homicide data from the FBI's Uniform Crime Reports revealed that there were approximately three additional justifiable homicides per year in Missouri following the adoption of the state's Stand Your Ground law above pre-SYG-law levels—less than 1 % of the total number of gun homicides during 2008–2010.

Critics could question the use of a relatively short pre-repeal baseline period used for this study. Using more longitudinal observations can potentially produce more accurate forecasts of the counterfactual in interrupted time-series impact studies.

However, the period from 1985 to 1998 included dramatic increases and decreases in US homicide rates. Experts believe that these changes were driven by factors that could not be directly measured (e.g., dynamics of the crack cocaine market, and changes in social norms)³² and thus controlled statistically and that these unmeasured forces appear to have been uneven across states.¹⁹ Such conditions pose considerable challenges for deriving unbiased estimates of policy impacts. By limiting the analyses to the relatively stable period of 1999–2012, we minimized the potential for omitted variable bias that would have likely been introduced by including data from this earlier time period.

The generalizability of our findings to other states with PTP handgun laws is unknown. Data from a recent cross-sectional study indicated that PTP licensing laws and universal background check requirements were associated with lower homicide rates after controlling for other population risk factors;⁹ however, the lack of longitudinal data weakens causal inference from that study. We caution, however, that passage of a PTP handgun licensing law with mandatory background checks and record keeping for all handgun sales may not result in as immediate and large a reduction in firearm homicides as occurred in reverse when Missouri's law was repealed. Although our findings indicate that Missouri benefited from the protective effects of its PTP law before the law's repeal, the beneficial effects of new laws of this type may be more gradual as enforcement practices are put in place, awareness of the law increases, and the stock of guns available in the underground market is depleted. Additional methodologically rigorous research of the impact of other laws of this type is warranted.

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Declaration Exhibit 6



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Effects of changes in permit-to-purchase handgun laws in Connecticut and Missouri on suicide rates

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ABSTRACT

Objective. In 2013, more than 40,000 individuals died from suicide in the United States. Restricting access to lethal means has the potential to prevent suicide, as suicidal thoughts are often transient. Permit-to-purchase (PTP) laws for handguns could potentially reduce suicides by making it more difficult for persons at risk of suicide to purchase a handgun.

Methods. We used a quasi-experimental research design with annual, state-level suicide data to evaluate changes to PTP laws in Connecticut and Missouri. Data were analyzed for 1981–2012. We used synthetic control modeling as the primary method to estimate policy effects. This methodology provided better prediction of pre-PTP-law-change trends in the two states with PTP law changes than econometric models and is thus likely to provide more accurate estimates of policy effects.

Results. The synthetic control model estimated a 15.4% reduction in firearm suicide rates associated with Connecticut's PTP law. Missouri's PTP law repeal was associated with a 16.1% increase in firearm suicide rates. Evidence that PTP laws were associated with non-firearm suicide rates was mixed in Connecticut and negative in Missouri.

Conclusion. The findings are consistent with prior research linking firearm availability to increased risk of suicide and lower suicide risks associated with PTP handgun laws.

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Introduction

In the United States, suicide is the second leading cause of death for persons age 15–34 years, and the tenth leading cause of death overall (CDC, 2015a). In 2013 alone, more than 40,000 individuals lost their lives to suicide, compared to approximately 16,000 homicides (CDC, 2015b). More than half of all suicides were committed with a firearm (CDC, 2015a).

Household-level and state-level studies have found that access to firearms is positively associated with suicide risk after controlling for other risk factors (Anglemyer et al., 2014). Case fatality rates for suicide attempts by firearm exceed 90% (Miller et al., 2004). Though many commonly think that a person contemplating suicide will use an equally lethal alternative method if the original means of suicide is restricted, suicidal ideation is often transient (Miller et al., 2006; Deisenhammer et al., 2009). And for many individuals attempting suicide, the time between suicidal ideation and attempt can be as little as 10 min (Deisenhammer et al., 2009). If a person's access to particularly lethal means can be restricted during periods of distress or impulsivity, a suicide may be prevented. For these reasons, suicide prevention research

has explored what impact lethal means restriction can have on suicide attempts and completion (Hawton, 2007; Barber & Miller, 2014).

Laws requiring permits to purchase firearms represent one method of means restriction for firearms, especially for some high-risk individuals, which require handgun purchasers to obtain a permit-to-purchase (PTP) that is contingent upon the applicant passing a background check. These PTP laws typically require an in-person application at a law enforcement agency and, in some cases, applicants must successfully complete safety training and experience significant waits for review. Permits are required for virtually all transfers of handguns including those conducted by private unlicensed sellers. A background check requirement for private sales should prevent a sale to someone with a prohibiting condition that reflects heightened risk for suicide, including conviction for violent crimes, being under a restraining order for domestic violence, multiple offenses involving drugs or alcohol abuse, and being involuntarily committed to a mental hospital or found by a court to be a threat to themselves or others due to mental illness. Also, the additional time required to obtain a gun in states with a PTP law could restrict access to firearms among those not already owning firearms during times of suicidal ideation or planning. Federal law does not require a permit or background check for handgun purchasers are only required under federal law if the seller is a licensed gun dealer.

Missouri had a PTP law for handguns in place beginning in 1921. Any one wanting to legally purchase a handgun from a licensed dealer or

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private seller was required to apply in-person at a local sheriff's office. A PTP for a handgun was issued to approved individuals and good for 30 days. Missouri's PTP law was repealed effective August 28, 2007, reducing a barrier to handgun access for prohibited persons. Prior research evidence indicates that the PTP law repeal was associated with an increase in the diversion of guns to criminals (Webster et al., 2013) and homicides committed by firearms in Missouri (Webster et al., 2014).

Prior to 1995, Connecticut's laws regarding background checks for handgun sales could be characterized as vague. In 1965, the state enacted a law requiring all handgun sellers and buyers to use a written application that was to be mailed to the local authorities prior to a sale. If that municipal authority were to "have knowledge" that the buyer had a felony conviction, then the authority would notify that seller that no sale could take place. A one week waiting period – extended to two weeks in 1975 – was also instituted. A new state law went into effect in October 1994, establishing an optional eligibility certificate for handgun buyers that could be issued by local authorities upon the purchaser passing a background check. Holders of an eligibility certificate for handgun purchases were not required to comply with the waiting period. Local authorities were instructed to make a "reasonable effort" to determine if any applicant was ineligible to own a handgun. It was not until October 1, 1995 that Connecticut established a mandatory PTP system applicable to all handgun buyers and made it illegal to sell a handgun to anyone who did not have an eligibility certificate. Such certificates required the applicant to pass a background check and successfully complete an 8-hour handgun safety course. A recent study demonstrated that enactment of Connecticut's PTP law was associated with decreases in firearm homicides and had no impact on homicides committed by other means (Rudolph et al., 2015).

The current study was designed to estimate the effects that these two changes in PTP handgun laws had on suicide rates. Prior research has shown a negative association between the presence of PTP laws and suicide rates; (Andrés & Hempstead, 2011; Fleegler et al., 2013) however, most of the variation examined in these studies was cross-sectional and did not focus on whether the policies changed the risk of suicides over time in states when they adopted or repealed a PTP law. A recently published study by Anestis et al. (Anestis et al., 2015) also explored this topic, however, this study had important limitations including that it principally estimated cross-sectional associations. Our study seeks to provide a thorough and rigorous evaluation of the impact of changing PTP handgun laws on suicide in Connecticut and Missouri.

Methods

Design

A quasi-experimental research design was used with annual, state-level suicide rates and counts to contrast differences pre- versus post-PTP law change in Connecticut and Missouri compared with states that did not experience a PTP law change. State-level data for suicides were available for the years 1981–2012. Suicides were stratified by mechanism (firearm vs. non-firearm) to test the specificity of the policy effects and examine if possible method substitution occurred following the PTP law change.

Data

Suicide data were accessed from the Centers for Disease Control and Prevention's Web-based Injury Statistics Query and Reporting System (WISQARS) (CDC, 2015c) for years 1981–2007. For data after 2007, WISQARS suppresses the data if counts for individual state-years are less than 10 – which was particularly prevalent when examining the data within age strata. Data were obtained for years 2008–2012 through a request to the National Association for Public Health Statistics and Information Systems (NAPHSIS, National Association for Public Health Statistics and Information Systems, 2014).

The analyses controlled for a number of factors previously associated with suicide rates at the state level including: unemployment; poverty; demographics (percentage of the population that was male, black, Hispanic, married, completed high school, a military veteran, or who lived in a Metropolitan Statistical Area

(MSA)), per capita consumption of ethanol spirits, firearm availability, and rate of religious adherence. The analyses also included control variables for states with strong mental health parity laws because access to mental health services could protect against suicides.

Annual unemployment rates (per 100 population age 16 or older) were accessed from the Bureau of Labor Statistics (BLS, 2012). Poverty rates (per 100 population) were from the Current Population Survey (Census, 2012a). Percent MSA was obtained from the Crime in the United States reports (FBI, 2012). The proportions of state population that were black or Hispanic were from the Census Bureau and interpolated between census years (Census, 2012b). Marital status, percent completing high school, proportion male, and proportion of the state that are military veterans were accessed from Census data and the American Community Survey (Census, 2015). Per capita ethanol spirit consumption was obtained from National Institute on Alcohol Abuse and Alcoholism (NIAAA, 2014). Rates of religious adherence were obtained from the Religion and Congregation Membership Survey interpolated between census years (ARDA, 2014). A commonly used firearm availability proxy (ratio of firearm suicides to all suicides) was created using data from WISQARS (used only to improve matching in the synthetic control models) (CDC, 2015c).

A significant challenge to deriving valid estimates of the impact of new state policies on public health and safety outcomes is the considerable heterogeneity among states and the inability to directly measure important factors that influence trends that vary across states. An innovative approach for dealing with this challenge is creating so-called "synthetic controls" to estimate the counterfactual for states that adopt new policies. This method uses data from a pool of potential comparison states that do not have the type of law being evaluated to create a synthetic control. This synthetic control is derived from a combination of observations from the comparison pool that are weighted according to their ability to accurately predict the pre-law trends in the outcome variable of the state where the law of interest is being changed. This approach can produce a more accurate counterfactual for the state where the law change occurs and therefore a more accurate estimate of a policy impact than analytic approaches that estimate policy effects based on a much broader set of data that include non-intervention comparisons that may be substantially different from the intervention state.

The synthetic control methodology avoids the heterogeneity assumption, that an intervention has constant effects across all observations, which underlies estimates derived from regression analyses. This methodology allows us to separately estimate the effects of a law's change on suicide for Connecticut and Missouri over different time periods.

To construct appropriate synthetic controls, we restricted the donor pool of comparison states for Connecticut's synthetic control to the 39 other states without a PTP handgun law in 1995. For Missouri, which repealed its PTP law in 2007, we included the other 9 states (excluding the District of Columbia and Connecticut) that had a PTP law in 2007. We used covariate and suicide data from 1981–2006 for Connecticut, which adopted its law in late 1995, avoiding extrapolation beyond ten years after the passage of Connecticut's PTP law as recommended by Abadie, Diamond, and Hainmueller (Abadie et al., 2010). For Missouri, which repealed its law in 2007, we used data from 1981–2012. Dependent variable rates were smoothed by analyzing three-year moving averages for Y_{t-1} , Y_t , and Y_{t+1} to ease interpretation of otherwise volatile data (Rudolph et al., 2015; Abadie et al., 2010; Abadie & Gardeazabal, 2003; Abadie et al., 2015). Separate analyses were performed for firearm suicides and non-firearm suicides to assess whether any estimates of policy effects were specific to firearm suicides and if the policy change was associated with method substitution. The synthetic controls' ability to predict pre-law-change trends in suicide rates in the states that changed their PTP laws was assessed by calculating the root mean square prediction error (RMSPE) and contrasting it with the RMSPE for a simple average of the entire pool of control states that were used to predict suicide rates in Connecticut and Missouri.

Because this method does not produce traditional p-values or tests of statistical significance, we performed so-called placebo tests with each of the states in the donor pool of control states for Connecticut and Missouri. Using firearm suicide rates, we ran the analyses with each state from the donor pool as if it were the "treated" state that experienced the PTP law change at the time that Connecticut or Missouri did. We then calculated the cumulative percent change in firearm suicides during the post-law change periods for Connecticut (1996–2005) and Missouri (2008–2012). We calculated the percent difference in cumulative post-law-change firearm and non-firearm suicide rates between the observed and the counterfactual estimated by each of the synthetic controls. This allowed us to examine the estimated percentage change associated with the changes in the PTP laws in Connecticut and Missouri in comparison to the percentage change estimates from the placebo tests in the states from each of

the respective donor pools of control states and thus assess how unique the changes observed in the intervention states were.

To compare the results of the synthetic control methods to a more traditional approach to policy evaluation, we also conducted standard econometric time series analyses. We used pooled time series with annual cross-sectional data from all 50 states to evaluate the associations between the passage (Connecticut – 1995) and repeal (Missouri – 2007) of the PTP laws and total, firearm, and non-firearm suicides. We created an indicator variable for each state (Connecticut and Missouri) to represent the state's change in PTP law status. For Connecticut, the indicator was coded as 0 prior to the passage of the law, a fraction for the proportion of the days in the year the law was in effect, and 1 for each subsequent year. The opposite was true for Missouri; the indicator was coded as 1 prior to the repeal, a fraction for the proportion of the days in the year the law was in effect, and 0 for each subsequent year without the law. To estimate the effects of a change in PTP law status and firearm suicides, we used negative binomial regression models using state and year fixed effects. Fixed effects were used to account for time-invariant factors and omitted variables that may be associated with suicides. Standard errors were adjusted to account for clustering by state. Negative binomial regression was used due to over-dispersion in the outcome variables. The same covariates as with the synthetic control models were used (excluding the gun availability proxy).

All analyses were conducted using Stata IC v. 13.0 (StataCorp, 2013). This study was deemed to be "not human subjects research" by the Johns Hopkins Bloomberg School of Public Health.

Results

Synthetic control model

Table 1 compares the mean value of predictors in the treated unit and the synthetic control for the period prior to the PTP law change. The means are averaged over the entire pre-law-change period except for the lagged firearm and non-firearm suicide rates.

Table 1

Predictor balance averaged over pre-law-change period for Connecticut, Missouri, and their synthetic controls.

	Connecticut	Synthetic control firearm suicides	Synthetic control non-firearm suicide
Percent white	89.8	94.2	90.0
Percent ages 18–34	27.4	28.8	28.0
Gun availability proxy*	0.44	0.38	0.61
Percentage with veteran status	16.9	17.1	17.1
Percentage male	47.4	47.4	48.0
Unemployment rate	5.14	5.94	6.60
State-years of any mental health parity law	0.00	0.00	0.00
Firearm/ non-firearm			
Suicide rate, 1981	3.68/4.93	3.81	4.93
Suicide rate, 1987	4.21/5.41	4.21	5.42
Suicide rate, 1994	4.41/5.13	4.41	5.13
Missouri			
Percent white	87.8	79.8	86.9
Percent ages 18–34	25.4	26.8	25.5
Gun availability proxy*	0.62	0.66	0.50
Percentage with veteran status	16.2	14.6	14.4
Percentage male	47.3	47.9	47.7
Unemployment rate	5.70	4.94	5.49
State-years of any mental health parity law	0.27	0.06	0.13
Firearm/ non-firearm			
Suicide rate, 1981	7.48/4.41	8.70	4.56
Suicide rate, 1993	8.43/4.38	8.33	4.47
Suicide rate, 2006	7.55/5.77	6.78	5.43

The intervention states and their respective synthetic controls are very similar on baseline suicide rates and predictors. There are some divergences between, for instance, the value of Connecticut's gun availability proxy and its synthetic control for firearm suicides and between Missouri's racial demographic composition and its synthetic control for firearm suicides. Several other predictors were used in sensitivity analyses including a measure of the urban population, per capita consumption of ethanol derived from spirits, a measure of poverty, and marital status. These additional predictors neither improved the pre-intervention fit nor substantially altered the results.

States with the largest weights for Connecticut's synthetic controls were Rhode Island (0.741) and North Dakota (0.259) for firearm suicides and Utah (0.332) and Pennsylvania (0.210). The largest weights for Missouri's synthetic controls were North Carolina (0.790) and Nebraska (0.210) for firearm suicides and Iowa (0.447) and New Jersey (0.285). **Appendix Table 1** lists all states with non-zero weights for the synthetic controls for each intervention state for firearm and non-firearm suicide rates. The prediction error (RMSPE) for the pre-law-change period produced by an average of all the states in the respective donor pools for each PTP law change studied were 19 times higher than the "synthetic Connecticut's" firearm suicide rates, 3.8 times higher than the "synthetic Connecticut's" non-firearm suicide rate, 6.9 times higher than "synthetic Missouri's" firearm suicide rates, and 3.2 times higher than "synthetic Missouri's" non-firearm suicide rates (**Table 2**). Prediction error for the baseline periods were 2 to 3 times higher in the synthetic control models for the 20–29 age group versus the synthetic control models for the overall state populations, yet was considerably lower than the prediction error when using the average of the donor pool states.

Figs. 1 and 2 show a panel of synthetic control analyses for Connecticut and Missouri, respectively for: (a) firearm suicide, (b) non-firearm suicide; (c) firearm suicide for persons age 20–29, and (d) non-firearm suicide rates for persons age 20–29. For firearm suicides, no systematic differences between Connecticut and its synthetic control are evident during the pre-law period. During the post-intervention period, Connecticut's firearm suicide rate consistently stays below that of its synthetic control. Connecticut's non-firearm suicide rate is relatively stable throughout the entire study period (**Fig. 1(b)**). After actual non-firearm suicide rates closely tracked the synthetic control during the pre-law period, the rate for Connecticut's synthetic control rose gradually above the actual rate for the state during the post law period. The pattern observed for Connecticut relative to its synthetic control for all firearm suicides is evident for firearm suicides among 20–29 year olds, though the departure of Connecticut's post-law trend from its synthetic control's path appears more pronounced (**Fig. 1(c)**). Among 20–29 year-olds, Connecticut's non-firearm suicide rate closely tracts its synthetic control until it dips well below its synthetic control during the middle years of the post-law period (1998–2002) (**Fig. 1(d)**).

Missouri's firearm suicide rates were slightly higher than its synthetic control's during the 1990s, but the difference began to grow the year prior to the PTP law repeal (2006) and the divergence grew over the 5-year period following the repeal of the PTP law when Missouri's rate is noticeably higher than the control (**Fig. 2(a)**). Missouri's non-firearm suicide rate tracks closely with that of its synthetic control throughout most of the study period with the actual rate slightly higher than its

Table 2

Root Mean Square Prediction Error (RMSPE) for the pre-law-change period for the synthetic controls for Connecticut and Missouri compared with the RMSPE for the average of all donor states who could have changed their PTP law at the time Connecticut's and Missouri's PTP laws changed.

	Connecticut		Missouri	
	Synthetic control	All donor states	Synthetic control	All donor states
Firearm suicides	0.27	5.03	0.52	3.58
Non-firearm suicides	0.13	0.50	0.14	0.47

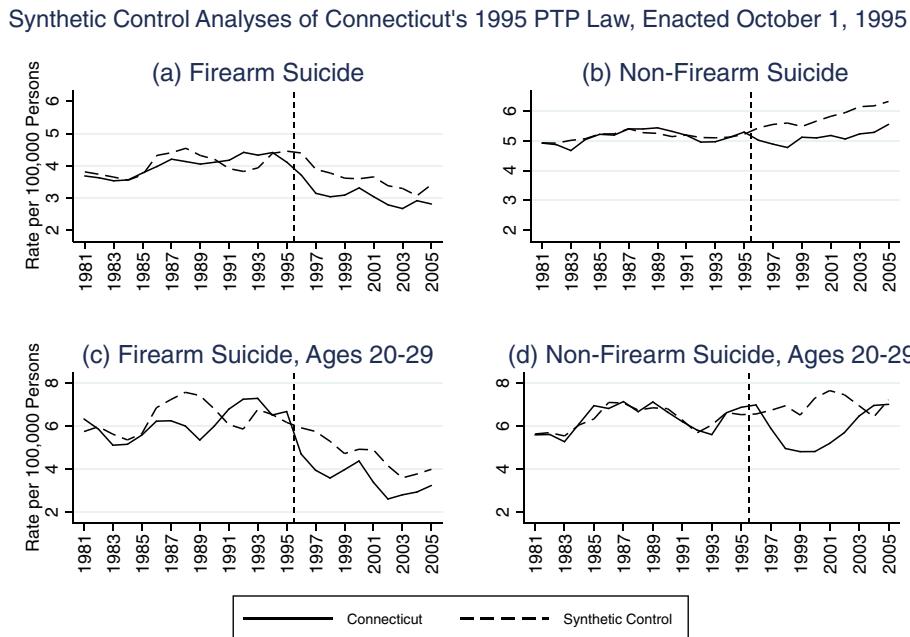


Fig. 1. Synthetic control analyses of Connecticut's PTP law, enacted October 1, 1995.

control 2006–2010 (Fig. 2(b)). Among persons age 20–29, Missouri's firearm suicide rate is above its synthetic control for much of the initial pre-intervention period; however, the actual and predicted rates are similar during the 8 years leading up to the law's repeal. During the post-repeal period, Missouri's firearm suicide rate among individuals age 20–29 increases and stays above that of the control (Fig. 2(c)). A similar pattern is evident for non-firearm suicide rates for age 20–29 except that the increase in Missouri relative to its control begins in 2005, prior to the repeal of the state's PTP law (Fig. 2(d)).

Connecticut's firearm suicide rates were 15.4% lower than that of its synthetic control during the 10-year post-law period. Fig. 3(a) shows that only 2 of the 39 control states experienced reductions in firearm suicides that were larger in percentage terms based on the placebo

tests. The largest percentage reduction in firearm suicide rates based on the placebo tests occurred in Rhode Island; however, its prediction error for the pre-law period revealed the worst model fit among the pool of control states. Connecticut's non-firearm suicide rates, however, were 11.9% lower during the post-law period than predicted by the synthetic control. Six states had percentage reductions in non-firearm suicide rates relative to their synthetic controls during 1996–2005 that were larger than Connecticut's (Fig. 3(c)).

The synthetic control model estimate for the effect of Missouri's repeal of its PTP law was 16.1% higher than the counterfactual during the 5-year post-law period. The increase in firearm suicides in Missouri following the repeal of its PTP law was unusual among states that had a PTP handgun law in 2006 (Fig. 3(b)). Among the donor pool of 9 control

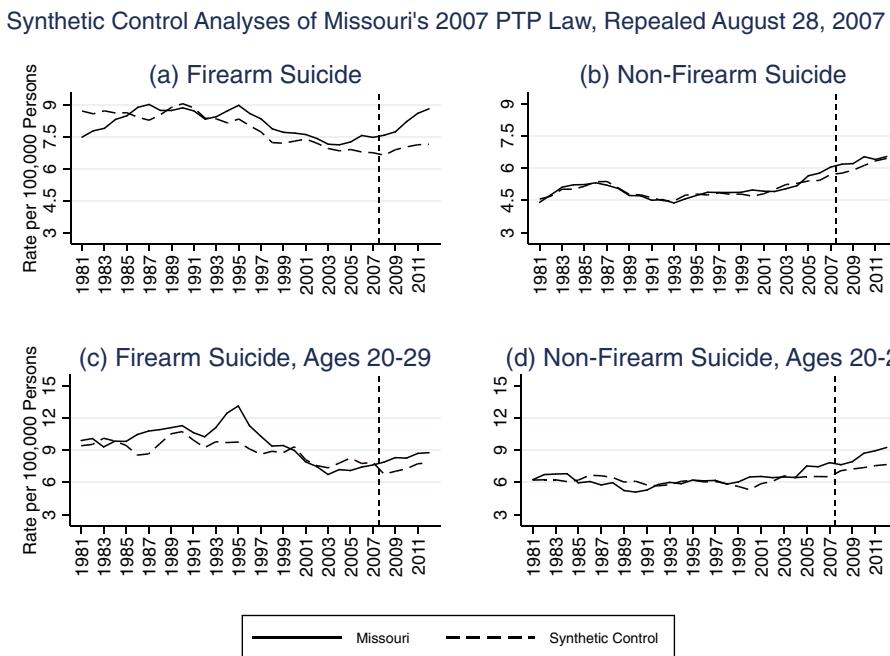


Fig. 2. Synthetic control analyses of Missouri's PTP law, repealed August 28, 2007.

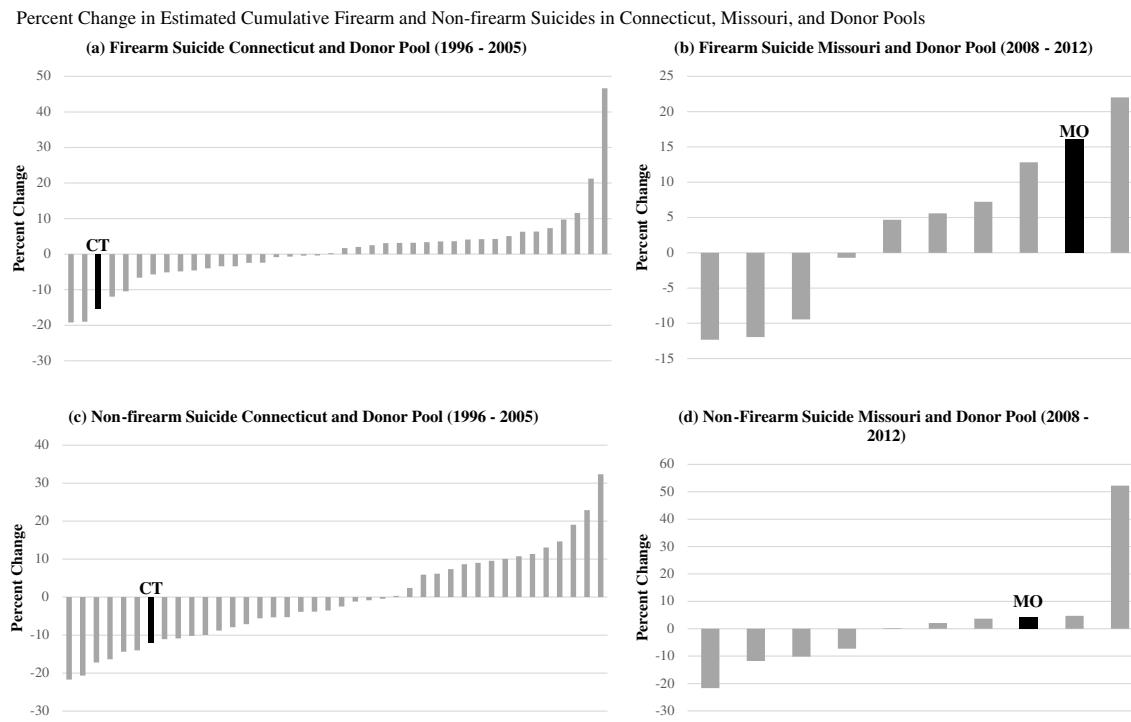


Fig. 3. Percent change in estimated firearm and non-firearm suicides in Connecticut, Missouri, and donor pools.

states for Missouri, only Hawaii's placebo test for policy effects at the same time as Missouri's law change produced a larger percentage increase in firearm suicide rates. However, Hawaii's synthetic control model produced the worst pre-law-change model fit among the pool of donor states and its baseline rate of firearm suicide was less than a third as high as that of Missouri's. In absolute terms, the increase in Hawaii's annual firearm suicide rates (0.61) during 2008–2012 was half that observed in Missouri (1.29). Missouri's non-firearm suicides were 4.2% higher than the control during the period after the PTP law repeal (Fig. 3(d)).

For the 20–29 year age group, Missouri's observed suicide rates after the PTP law repeal were 14.5% higher than that of the synthetic control for suicides committed with firearms and 15.0% higher for non-firearm suicides.

Alternative regression model estimates

The alternative method of estimating policy effects — negative binomial regression models with panel data from 50 states — produced estimates indicating that Connecticut's PTP law was associated with a 12% reduction in firearm suicide rates ($p = 0.004$), a 14% increase in rates of non-firearm suicide ($p = 0.002$), and no association with overall suicide rates. Among 20–29 year-olds, Connecticut's law was associated with a 28% reduction in firearm suicide rates ($p = 0.001$) and a 16% increase in non-firearm suicide rates ($p = 0.046$). The repeal of Missouri's PTP law was not associated with changes in any of the suicide measures (Appendix Table 2). Comparisons of the RMSPE for Connecticut and Missouri generated from these regression analyses reveal poor model fit compared with the synthetic control models.

Discussion

Prior research produced evidence suggesting that handgun purchaser licensing laws were associated with lower suicide rates, but focused principally on cross-sectional associations (Andrés & Hempstead, 2011; Fleegler et al., 2013; Anestis et al., 2015). This study investigates if recent changes in permit-to-purchase (PTP) handgun laws led to

changes in suicide rates in ways consistent with the hypothesis that these laws reduce suicides by decreasing the availability of a highly lethal means of suicide.

We applied a relatively new approach that has been used to study the effects of state laws on public health outcomes that identifies comparison states that, in combination, constitute so-called synthetic controls that best predict the outcome measures in the states where the policies of interest are changing. Using this method, we find some support for this hypothesis that PTP laws reduce suicides. Connecticut experienced a drop in its firearm suicide rate coincident with the adoption of a PTP handgun law that was greater than nearly all of the 39 other states that did not have such a law at that time and Missouri experienced an increase in its firearm suicide rate following the repeal of its PTP handgun law that was larger than all states that retained their PTP laws. The estimated effects of the PTP law on firearm suicide rates were more pronounced among individuals ages 20–29, the age at which young adult first become legally eligible to purchase handguns. What one infers about the strong negative association between Connecticut's PTP law and firearm suicide rates, depends on how one interprets the data on the law's association with non-firearm suicides. The synthetic control method indicated a reduction in non-firearm suicides associated with Connecticut's PTP law that was proportionately similar to that derived for firearm suicides. However, the estimate for non-firearm suicides was based principally on increases that occurred in the state's synthetic control during the post-law period when Connecticut's actual rate was stable. Further, the estimated effect was not so unusual relative to the placebo tests in the 39 other states without PTP laws in 1995. The regression analyses with 50 states' data estimated a large and statistically significant negative association between Connecticut's PTP law and firearm suicides rates, but a statistically significant positive association between the law and non-firearm suicide rates. Thus, the evidence that Connecticut's PTP law was associated with any change in non-firearm suicides is unclear at best.

Missouri's firearm suicide rates rose 16% over and above the counterfactual estimated by the synthetic control for the first 5 full years after the repeal of Missouri's PTP handgun law. The percentage increase was greater than 8 of the 9 other states that had a PTP law when

Missouri's was repealed and four times that estimated for Missouri's non-firearm suicide rates. We would expect the effects of the repeal of Missouri's PTP law would be more concentrated among those in their twenties; however, that was not evident.

Findings from the alternative method for estimating policy effects, negative binomial regressions using data from all 50 states, differ from those generated by the synthetic control method with the exception of also showing Connecticut's PTP law negatively associated with firearm suicide rates in the overall population and among the 20–29 age group. Inferences about the association between PTP laws and suicides for the other outcomes, therefore, depends on which method of estimating the counterfactual for suicide trends in the two states that changed their PTP laws is more accurate. The negative binomial models used data from all 50 states to generate treatment effects averaged across 50 states. We believe that the synthetic control approach is more defensible because it selects and weights comparison states based solely on how well the data from those states predict baseline suicide trends in the states that changed their PTP laws. As is evident by the data in Table 2, using data for the entire pool of donor states for Connecticut and Missouri regardless of how well those state's data predict suicide rates in the states that changed their PTP law can provide for a poor counterfactual for states with the law changes in comparison to that of synthetic controls. Furthermore, prediction error for Connecticut and Missouri's suicide rates from the negative binomial regression models was much greater than was produced by the synthetic control models.

There are several strengths to the study in addition to the use of synthetic controls to estimate temporal relationships between PTP laws and suicide rates. The analyses controlled for a number of state demographic characteristics that could be associated with the risk of suicide including the proportion of the state population who were military veterans in any given year. Since veterans are at increased risk of suicide compared to the general population, we controlled for this to ensure our results were attributed to the policy change and not some unmeasured factor. Finally, we tested the specificity of our results by examining the effects of the law changes on non-firearm suicides. Since means substitution is an important consideration when studying suicide, we were able to evaluate whether a substitution effect occurred due to means restriction after the passage of Connecticut's PTP law.

As with most evaluations of public policy, we cannot rule out the possibility that our estimates of the associations between PTP laws and suicide rates are confounded by unmeasured determinants of suicide correlated with changes in the laws. Furthermore, data are not available to ascertain whether the reductions in firearm suicides were experienced by groups legally prohibited from purchasing handguns or who might otherwise be deterred from purchasing handguns as a result of a law requiring handgun purchaser permits contingent upon applicants passing background checks and safety training requirements.

The use of synthetic control methods provides the best available estimates and suggests that the presence of a PTP law could prevent a significant number of suicides. Based on the nature of the synthetic control, however, these results do not provide a confidence interval leading to uncertainty around the point estimate. These laws appear to be protective in ways that you might hypothesize based on what is known about the role of firearms and risk of suicide, but it is unclear exactly what magnitude effect on lives saved these laws have. Despite these limitations, the current study finds evidence to suggest that PTP laws for handguns reduce suicide rates. Future research should explore other factors that may predict state-level suicide rates so that models to test the effects of policies that could serve as a form of means restriction produce more precise estimates of policy effects.

The findings of the study are relevant to physicians as it provides further evidence that reducing access to a firearm can prevent suicide. Physicians who treat patients at elevated risk for suicide can counsel patients and family members about the link between access to a firearm and suicide risk and the potential benefit of reducing firearm access. The

study also highlights the value of a population based approach to suicide prevention. Many who are at elevated risk for suicide do not seek care or have limited access to care and those who are seen may not follow the advice of physicians on matters related to firearms. A PTP law that would restrict access to handguns for individuals with a history of severe mental illness, criminal behavior, domestic violence or substance abuse, or by simply delaying access to a firearm during a time of crisis through an application review period could prevent suicide.

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Conflict of interest statement

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Appendix A

Appendix Table 1

States with non-zero weights for synthetic controls for Connecticut's and Missouri's firearm and non-firearm suicide rates.

	Firearm suicides	Non-firearm suicides
Connecticut		
Rhode Island	0.791	0.071
North Dakota	0.078	–
South Dakota		0.140
Pennsylvania	–	0.210
Utah	–	0.332
Arkansas	–	0.124
New Mexico	–	0.117
Mississippi		0.033
Missouri		
Nebraska	0.210	–
North Carolina	0.790	0.145
Iowa		0.447
Massachusetts		0.002
Michigan		0.121
New Jersey		0.285

Appendix Table 2

Estimates of the association between permit-to-purchase handgun laws changes in Connecticut and Missouri from negative binomial regression analyses* with data from 50 states for the years 1981–2012.

State	Total population	Age 20–29 years
<i>All methods suicides IRR (95% CI, p-value)</i>		
Connecticut	1.01 (0.95 to 1.08, p = 0.765)	0.92 (0.81 to 1.04, p = 0.175)
Missouri	1.03 (0.97 to 1.08, p = 0.326)	0.96 (0.86 to 1.07, p = 0.430)
<i>Firearm suicides IRR (95% CI, p-value)</i>		
Connecticut	0.88 (0.81 to 0.96, p = 0.004)**	0.70 (0.57 to 0.84, p < 0.001)**
Missouri	1.02 (0.96 to 1.09, p = 0.450)	0.97 (0.84 to 1.11, p = 0.619)
<i>Non-firearm suicides IRR (95% CI, p-value)</i>		
Connecticut	1.14 (1.05 to 1.24, p = 0.002)**	1.12 (0.96 to 1.31, p = 0.140)
Missouri	1.03 (0.95 to 1.11, p = 0.456)	0.93 (0.81 to 1.07, p = 0.317)

**Indicates p < 0.05.

*These analyses controlled for the presence of a strong parity law; percent MSA; per capita consumption of ethanol; percent poverty; unemployment; marital status; percent completed high school; percent male; percent veteran; and rate of religious adherence.

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Declaration Exhibit 7



Association between Firearm Laws and Homicide in Urban Counties

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Abstract Laws related to the sale, use, and carrying of firearms have been associated with differences in firearm homicide rates at the state level. Right-to-carry (RTC) and stand your ground (SYG) laws are associated with increases in firearm homicide; permit-to-purchase (PTP) laws and those prohibiting individuals convicted of violent misdemeanors (VM) have been associated with decreases in firearm homicide. Evidence for the effect of comprehensive background checks (CBC) not tied to PTP is inconclusive. Because firearm homicide tends to concentrate in urban areas, this study was designed to test the effects of firearm laws on homicide in large, urban U.S. counties. We conducted a longitudinal study using an interrupted time series design to evaluate the effect of firearm laws on homicide in large, urban U.S. counties from 1984 to 2015 ($N=136$). We used mixed effects Poisson regression models with random intercepts for counties and year fixed effects to account for national trends. Models also included county and state characteristics associated with violence. Homicide was stratified by firearm versus all other methods to test for specificity of the laws' effects. PTP laws were associated with a 14% reduction in firearm homicide in large, urban counties

(IRR = 0.86, 95% CI 0.82–0.90). CBC-only, SYG, RTC, and VM laws were all associated with increases in firearm homicide. None of the laws were associated with differences in non-firearm homicide rates. These findings are consistent with prior research at the state level showing PTP laws are associated with decreased firearm homicide. Testing the effects of PTP laws specifically in large, urban counties strengthens available evidence by isolating the effects in the geographic locations in which firearm homicides concentrate.

Keywords Gun policy · Firearm · Homicide

Introduction

In 2016, there were 14,415 firearm homicides in the United States (U.S.), which accounted for nearly 75% of all homicides [1]. Firearm homicides are not distributed equally across the U.S.; 63% occurred in large, urban counties (classified as Large Central Metro and Large Fringe Metro by the U.S. Census Bureau) which contain 56% of the U.S. population [2]. States have enacted policies in response to firearm homicide, but the effect of these policies specifically in urban areas is unknown. In this study, we aim to evaluate the effect of five firearm-related policies on homicide in large, urban counties: comprehensive background checks, permit-to-purchase, right-to-carry, stand your ground, and violent misdemeanor prohibitions.

Weaknesses in federal law allow prohibited individuals to obtain firearms through unregulated private

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sales. Currently, only nineteen¹ states and the District of Columbia have laws requiring point of sale background checks be conducted when the seller is a private party. These laws are often referred to as comprehensive background check (CBC) laws. CBC laws require all sellers, both licensed retailers and private parties, to make firearm transfers contingent on the purchaser passing a background check. Private sales include those made at gun shows, sales arranged between strangers online, and transfers between friends and acquaintances. The most recent estimate by Miller and colleagues suggests that approximately 20% of guns are obtained without a background check [3]. In the 13 states with the least restrictive firearm laws, state prison inmates who were incarcerated for a gun crime were more likely to report obtaining that gun through an unregulated private sale than from a licensed dealer [4]. Data on recovered crime guns suggest more than 80% of criminals using firearms to commit crime were not the purchaser of record [5]. There is inconclusive evidence on the effect of background checks for private sales on firearm homicide at the state level.

Realizing that requiring background checks for private sales may, by itself, not be sufficient, ten states and the District of Columbia have an additional handgun purchaser licensing requirement; often referred to as permit-to-purchase (PTP) laws. PTP laws typically require that prospective handgun purchasers apply directly to a state or local law enforcement agency, many require applicants to submit fingerprints, for a purchase permit prior to approaching a seller. PTP laws may include a more thorough background check which law enforcement can take 30 days or more to complete. Sellers, both licensed and private, can only sell to someone with a valid purchase permit which is valid for varying lengths. States with longer duration permits may also require a point of sale background check to ensure that the purchaser has not become prohibited since the issuance of the permit. Prior research has found that PTP laws are associated with reductions in the diversion of guns to criminals [6] and gun homicide [7, 8].

It is important to note the differences between CBC and PTP laws because they are often conflated in research when in fact they are implemented differently, in ways that may influence their effectiveness. CBC laws generally depend upon the use of the National Instant

Criminal Background Check System (NICS) that is also used by licensed dealers; however, issues with the NICS have been identified related to the which records are reported to the system and the quality and timeliness of records that are reported [9]. PTP laws provide a longer period for law enforcement to conduct its background check at the local level, and these checks may have access to more records increasing the likelihood that law enforcement can identify and screen out those with a prohibiting condition.

Right-to-carry (RTC) laws require law enforcement to issue concealed carry permits to any individual that meets objective criteria or allow for permitless carry (permitless carry allows for individuals who are not otherwise prohibited from gun ownership to carry without obtaining a permit). RTC laws make it easier for individuals to carry loaded, concealed firearms in public spaces, and may require little or no safety training or demonstrations of competence and proficiency. Previous research suggests that RTC laws are associated with increased rates of violence at the state level [10, 11].

Stand your ground (SYG) laws are those that give individuals expanded protections for use of deadly force in a response to a perceived threat with no duty to retreat. These laws may make otherwise non-lethal encounters deadly if individuals are carrying loaded, concealed firearms, and feel emboldened to use their firearms in self-defense rather than leaving or de-escalating a volatile situation. Research on SYG laws shows they are associated with increases in rates of state-level firearm homicide [12, 13].

Violent misdemeanor (VM) prohibitions extend criminal prohibiting conditions for the purchase of a firearm to those who have been convicted of a misdemeanor crime of violence. States with these laws recognize that prohibiting a broader pool of potentially risky firearm owners may screen out individuals at risk of committing violence but who have not yet been convicted of a felony or domestic violence misdemeanor. Previous research showed decreased risk of future gun crime among those prohibited for a VM crime [14]. A recent study by Zeoli et al. found lower rates of intimate partner homicide in states with VM prohibitions [15].

Studies evaluating the effect of CBC, PTP, RTC, SYG, and VM laws on firearm homicide have been conducted at the state level. However, firearm homicide occurs more frequently in urban areas, so evaluations at the state level may underestimate the effectiveness of these laws in the places where homicides predominate.

¹ While Nevada passed a CBC law, there are implementation issues related to how the law was written and whether it will be enforced.

This study sought to explore the effects of these firearm laws on homicide in large, urban counties where firearm homicide is more likely to occur. We also sought to separate out the effects of states with CBC-only laws and those with PTP. Based on prior research, we hypothesized that PTP and VM laws would be associated with protective effects on homicide rates, CBC-only laws would have no effect, and RTC and SYG would be associated with harmful effects.

Methods

Design

We conducted a quasi-experimental longitudinal study using an interrupted time series to evaluate the effect of firearm laws on homicide in large, urban U.S. counties from 1984 to 2015. Because these laws are related to firearms, county-year counts of homicide were stratified by firearm versus all other methods to test for specificity of the laws' effects.

Data and Measures

Based on previous research, we hypothesized that, due to the specificity of the laws regarding firearms, changes to these laws would affect only firearm homicides. The primary outcome for the study was annual, county-level counts of firearm homicide obtained from the Centers for Disease Control and Prevention's Wide-ranging Online Data for Epidemiologic Research (WONDER) system [16]. Because firearm homicide tends to concentrate in urban areas, we restricted our analysis to counties with U.S. Census urbanization codes of "Large Central Metro" and "Large Fringe Metro" and populations greater than 200,000 across the study period resulting in a sample that contained 136 counties over 32 years for a total of 4352 county-year observations.²

We accessed additional county-level variables from WONDER including the percent of the population who were African American males age 15–24 and county population. County-level percent poverty was obtained from the U.S. Census and interpolated

between census years [17]. Average annual measures of county-level unemployment were obtained from the Bureau of Labor Statistics Local Area Unemployment Statistics [18]. State-level variables were used for two covariates that were not readily available at the county level: incarceration rates [19] and state law enforcement expenditures [20].

We conducted legal research to identify the effective dates for each state's policies including month, day, and year. Indicators for policy variables were generated based on these effective dates. Policy indicators were coded as 1 when a law was in effect and 0 otherwise. To reduce measurement error, the policy indicators were coded as a proportion for the number of days the policy was in effect in the year in which a policy was first implemented (see Table 1).

Exploratory data analysis revealed outliers for non-firearm homicide counts for counties near New York City in 2001 due to the attack at the World Trade Center; nearly 3000 additional lives were lost due to non-firearm homicide. For counties within approximately 50 miles of New York City, we excluded the counts of non-firearm homicide for 2001 only.

Analytic Methods

We conducted an interrupted time series analysis to estimate the effects of firearm laws on county-level firearm homicide. We used non-firearm homicide as a negative control to test for the specificity of the laws' effects. We used mixed effects Poisson regression models to account for repeated measures by county and allow counties to have unique intercepts; the likelihood ratio test for mixed effects versus a Poisson model indicated the need for random intercepts ($p < 0.001$).

County-level percent poverty, unemployment, and African American males age 15–24, state-level incarceration rates, and law enforcement expenditures were included in the final model. Year fixed effects were used to account for national trends in homicide and county-level population was included as an offset to generate incident rate ratios (IRRs). Additionally, models were run with and without a county-level proxy for firearm ownership (the ratio of firearm suicide to all suicide). Analyses were conducted using Stata IC v 14.2 [21]. This study was deemed to be "not human subjects research" by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

² States with no counties that met the inclusion criteria: Alaska, Arkansas, Hawaii, Idaho, Iowa, Maine, Mississippi, Montana, Nebraska, New Mexico, North Dakota, South Carolina, South Dakota, Vermont, West Virginia, and Wyoming

Table 1 Firearm laws and effective dates by state

State (# of counties)	Permit to purchase	Comprehensive background check only	Right to carry	Stand your ground	Violent misdemeanor restriction
Alabama (1)			Pre-1984	6/1/06	
Arizona (1)			4/13/94	4/24/06	
California (12)		1/1/91			1/1/91
Colorado (4)		7/1/13		5/17/03	
Connecticut (1)	10/1/95				
Delaware (1)		7/1/13			
Florida (9)			10/1/87	10/1/05	
Georgia (4)			8/25/89	7/1/06	
Illinois (7)	Pre-1984		1/5/14		1/1/95
Indiana (2)		Pre-1984–11/30/98	Pre-1984	7/1/06	
Kansas (1)			1/1/07	5/26/06	
Kentucky (1)			10/1/96	7/12/06	
Louisiana (2)			4/19/96	8/1/06	
Maryland (5)	10/1/13	10/1/96–10/1/13			10/1/03
Massachusetts (6)	Pre-1984				
Michigan (4)	Pre-1984		7/1/01	10/1/06	
Minnesota (4)			5/28/03		10/1/03
Missouri (3)	Pre-1984–8/28/07		2/26/04	8/28/07	
Nevada (1)			10/1/95	10/1/11	
New Hampshire (1)			Pre-1984	11/13/11	
New Jersey (13)	Pre-1984				
New York (14)	Pre-1984				Pre-1984
North Carolina (2)	Pre-1984		12/1/95	12/1/11	
Ohio (6)			4/8/04		
Oklahoma (1)			1/1/96	11/1/06	
Oregon (3)		8/9/2015	1/1/90		
Pennsylvania (8)		10/11/95	6/17/89	8/29/11	
Rhode Island (1)		Pre-1984	Pre-1984		
Tennessee (2)		5/10/94–11/1/98	10/1/96	5/22/07	
Texas (6)			1/1/96	9/1/07	
Utah (1)			5/1/95	3/1/94	
Virginia (3)			5/5/95		
Washington (4)		12/4/14	Pre-1984		
Wisconsin (2)			11/1/11		
Total states with law during study period (total # of changes)	9 (3)	10 (9)	27 (22)	18 (18)	5 (4)

Results

Table 1 presents the laws included in the study and the associated effective dates by state for those states with counties that met our inclusion criteria.

Table 2 presents the effects of the firearm policies we examined on firearm homicide in large, urban counties after controlling for identified covariates. PTP laws were associated with a 14% reduction in firearm homicide (IRR = 0.86, 95% CI 0.82–0.90). CBC-only laws were

Table 2 Effects of firearm laws on firearm homicide in large, urban U.S. counties, 1984–2015

	IRR ^a	95% CI ^b
Permit to purchase	0.86	0.82–0.90
Comprehensive background check only	1.16	1.13–1.18
Right to carry	1.04	1.02–1.06
Stand your ground	1.07	1.05–1.10
Violent misdemeanor prohibitions	1.14	1.12–1.17
County-level % population African American male youth	1.53	1.49–1.57
County-level poverty rate	1.00	1.00–1.00
County-level unemployment rate	1.00	1.00–1.01
State-level incarceration rate	1.00	1.00–1.00
State-level law enforcement expenditures	0.99	0.99–0.99

The model also included year fixed effects

^a Incidence rate ratio

^b 95% confidence interval

associated with a 16% increase in firearm homicide (IRR = 1.16, 95% CI 1.13–1.18). RTC laws were associated with a 4% increase in firearm homicide (IRR = 1.04, 95% CI 1.02–1.06). SYG laws were associated with a 7% increase in firearm homicide (IRR = 1.07, 95% CI 1.05–1.10). VM laws were associated with a 14% increase in firearm homicide (IRR = 1.16, 95% CI 1.12–1.17). When we included the proxy for county-level firearm ownership, there were negligible differences in the point estimates; however, the firearm ownership proxy itself was associated with a 37% increase in firearm homicide (IRR = 1.37, 95% CI 1.26–1.49).

Because of the IRR estimates for CBC-only and VM laws were in the direction opposite to our hypotheses, we also tested the effects of 1-, 2-, and 3-year leads and lags of the laws. These estimates reveal firearm homicide rates trending upward in the years immediately prior to CBC-only (Fig. 1) and VM laws (Fig. 2) going into effect with statistically significant increased firearm homicide rates 1 year prior to the laws' introduction. The IRRs were above 1.0 each year following the introduction of CBC-only and VM laws, but leveled off for CBC-only and were essentially the same as the 1-year lead for VM laws.

Table 3 presents the effects of the same set of firearm policies on non-firearm homicide rates. None of the firearm policy variables of interest were associated with changes in non-firearm homicide, supporting the specificity of the laws' effects. When we included the proxy for county-level firearm ownership, there were

negligible differences in the point estimates; however, the firearm ownership proxy itself was associated with an 18% reduction in non-firearm homicide (IRR = 0.82, 95% CI 0.73–0.92).

Discussion

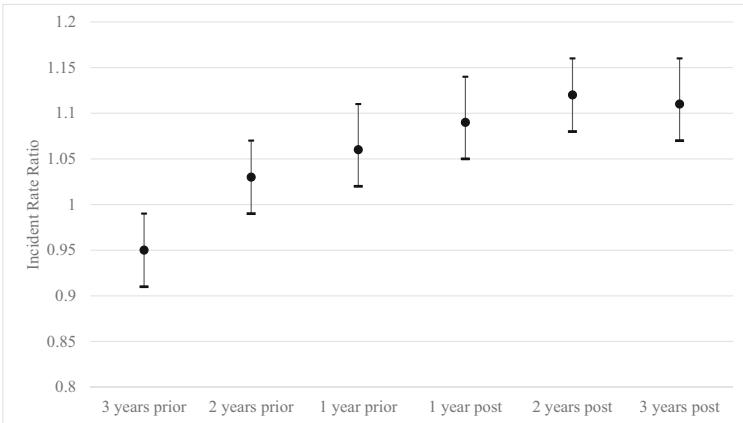
This study is the first study to our knowledge that examines the impact of PTP laws in large, urban counties where firearm homicide is more likely to occur. Our study also is the first to separate the impacts of CBC laws from PTP to understand how CBC laws affect firearm homicide independent from a permitting mechanism. Our study also examined the effects of other firearm-related policies on firearm homicide.

Our results are consistent with previous research finding that PTP reduces firearm homicides without increasing homicides by other means. However, we saw no benefit of a CBC system without a PTP law. It is possible that the application process required to obtain a permit, which puts the purchaser directly in contact with law enforcement, acts to hold potential purchasers more accountable and reduces the likelihood of straw purchases made on behalf of prohibited persons. The added time to conduct the background check at the local level may also make it easier to identify and screen out prohibited individuals who may be at increased risk of using that firearm to commit a homicide. Additionally, the built-in waiting period as part of the permitting process may prevent impulsive firearms purchases.

Our study suggests an increased risk of firearm homicide in large, urban counties associated with enactment of RTC laws which is consistent with previous research conducted at the state level. Counties in states with RTC laws experienced a 4% increase in firearm homicide relative to counties in states with more restrictions on the issuance of concealed carry weapons permits. Future research should explore whether specific elements of RTC laws, or lack thereof, have differential impacts on firearm homicide. For example, some RTC states allow law enforcement to deny issuing a concealed carry permit based on "dangerousness," or require a demonstration of proficiency. These differences can inform policy discussions around which elements, if any, may mitigate the harmful effects of expanded carrying of loaded, concealed firearms by civilians.

Our findings related to the effects of SYG laws are also consistent with previous research on the effects of

Fig. 1 Effects of CBC-only laws on firearm homicide 1-, 2-, and 3-year pre- and post-enactment



these laws on state-level firearm homicide [12, 13]. Counties in states with SYG laws experienced a 7% increase in firearm homicide. SYG laws are common in states with RTC laws and a high prevalence of gun ownership. Removing a duty to retreat in the context of populations with many armed individuals appears to increase firearm homicide.

In contrast to recent research finding protective effects of prohibitions for violent misdemeanants on intimate partner homicide [15], our study found increased risk of firearm homicide in counties of states with VM laws. However, the increased IRR for firearm homicide associated with VM laws in the year prior to the effective date suggests that the conditions influencing the passage of VM laws may increase firearm homicides. Identifying and controlling for such factors is necessary to generate unbiased estimates of the VM law effects. Future research should explore the effects of VM laws on firearm homicide in suburban and rural counties.

The increase in firearm homicide associated with CBC-only laws should be explored further. It is possible

that CBC-only laws are harmful; however, we have not identified a plausible theory to explain how requiring a prospective firearm purchaser to undergo a background check would result in increased homicide rates. It is possible that states experiencing historically high rates of firearm homicide during the late 1980s and early 1990s were more likely to implement CBC-only laws to reduce violence. If these states then experienced slower declines in firearm homicide compared to states that did not pass these laws, the CBC-only laws would appear harmful in our analysis. The upward trend in the IRRs for CBC-only laws in the 3 years prior to implementation, and the statistically significant increased rate for CBC-only laws in the year prior, suggests there may be an endogenous relationship between CBC-only laws and firearm homicide such that states may have passed these laws in response to increasing rates of firearm homicide. The lack of any beneficial effect of CBC-only laws could also reflect issues related to enforcement of CBC-only laws. The enforceability challenges associated with CBC-only laws are beginning to be

Fig. 2 Effects of VM laws on firearm homicide 1-, 2-, and 3-year pre- and post-enactment

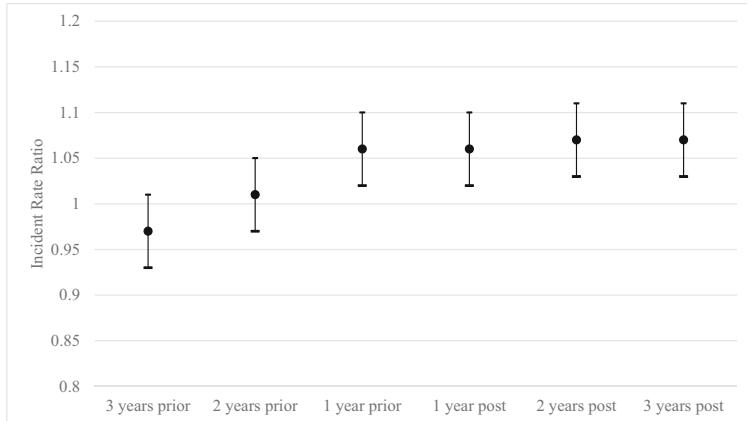


Table 3 Effects of firearm laws on non-firearm homicide in large, urban U.S. counties, 1984–2015

	IRR ^a	95% CI ^b
Permit to purchase	1.04	0.97–1.13
Comprehensive background check only	0.97	0.94–1.01
Right to carry law	1.03	1.00–1.06
Stand your ground	1.01	0.97–1.04
Violent misdemeanor prohibitions	0.99	0.96–1.02
County-level % population African American male youth	1.52	1.47–1.58
County-level poverty rate	1.01	1.00–1.02
County-level unemployment rate	0.99	0.99–1.00
State-level incarceration rate	1.00	1.00–1.00
State-level law enforcement expenditures	1.00	1.00–1.00

The model also included year fixed effects

^a Incidence rate ratio

^b 95% confidence interval

documented.[22, 23] PTP laws may be easier to comply with and enforce than CBC-only laws since sellers can only transfer a firearm to someone who has a valid permit. Future research should expand the inclusion criteria for county population size and/or urbanization. This may also allow for more states to be represented in the data and produce more robust results. Within PTP and CBC-only laws, there remain differences among states, including standards for obtaining the permit, duration of the permit, and whether a point-of-sale background check is also required in PTP states. These issues warrant additional research. Additionally, future research should explore the effects of these laws on firearm suicide at the county level.

There are some limitations to our study. As with all observational studies, there is a risk of selection bias as states choose whether to pass a policy or not. However, we attempted to minimize this bias by including county-level demographics and pre-law enactment data to estimate baseline trends. Importantly, our assessment of the effects of CBC-only and VM laws in the years prior to the laws going into effect underscores the challenges of studies of this type where omitted variables may bias estimates of the laws' impacts. This study only includes counties classified as the most urban with populations of 200,000 or greater across the entire study period. These counties may be different from those not included. Our inclusion criteria also excluded counties that may have had a population of 200,000 or more at some point

during the study period but did not maintain that population level across the entire study period. However, limiting our sample to large, urban counties where firearm homicide is more likely to occur would give us more reliable estimates of policy effects. Our study relied on two covariates that were not readily available at the county level. For example, law enforcement expenditures were only available at the state level.

This study adds to the growing body of evidence that PTP laws are associated with reductions in firearm homicide. States that are considering a range of policies related to the transfer of firearms should consider a handgun purchaser licensing system through a PTP law as a mechanism to reduce firearm homicide.

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Association between Firearm Laws and Homicide in Urban Counties

C.K. Crifasi et al.

Correction to: Association between Firearm Laws and Homicide in Urban Counties

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The authors would like to publish this erratum to correct estimates generated from regression analyses due to errors discovered in the coding of some state laws. The following corrections to the laws in Table 1 are warranted: 1) Michigan no longer requires a permit-to-purchase for handgun sales by licensed dealers effective December 18, 2012 (permits are still necessary for private transfers); 2) Connecticut enacted a law prohibiting firearm purchases for violent misdemeanants effective October 1, 1994; and 3) the implementation dates for violent

misdemeanant prohibition laws are January 1, 1996 for Illinois, October 1, 1996 for Maryland, and August 1, 2003 for Minnesota. We regret that we did not identify the errors prior to publication. The data presented below reflect the study's findings after these corrections were made. Changes to the point estimates for the laws' association with homicide rates were minor, and the direction and significance level of the estimates for the effects of the laws studied on firearm homicide did not change. The largest change was to the IRR for laws prohibiting firearms for violent misdemeanants' association with firearm homicide rates, which went from 1.14 to 1.24.

Table 1

Firearm Laws and Effective Dates by State.

State (# of Counties)	Permit to Purchase	Comprehensive Background Check Only	Right to Carry	Stand Your Ground	Violent Misdemeanor Restriction
Alabama (1)			pre-1984	6/1/06	
Arizona (1)			4/13/94	4/24/06	
California (12)		1/1/91			1/1/91
Colorado (4)		7/1/13	5/17/03		
Connecticut (1)	10/1/95				10/1/94
Delaware (1)		7/1/13			
Florida (9)			10/1/87	10/1/05	
Georgia (4)			8/25/89	7/1/06	
Illinois (7)	pre-1984		1/5/14		1/1/96
Indiana (2)		pre-1984–11/30/98	pre-1984	7/1/06	
Kansas (1)			1/1/07	5/26/06	
Kentucky (1)			10/1/96	7/12/06	
Louisiana (2)			4/19/96	8/1/06	
Maryland (5)	10/1/13	10/1/96–10/1/13			10/1/96
Massachusetts (6)	pre-1984				
Michigan (4)	pre-1984–12/18/12		7/1/01	10/1/06	

State (# of Counties)	Permit to Purchase	Comprehensive Background Check Only	Right to Carry	Stand Your Ground	Violent Misdemeanor Restriction
Minnesota (4)			5/28/03		8/1/03
Missouri (3)	pre-1984–8/28/07		2/26/04	8/28/07	
Nevada (1)			10/1/95	10/1/11	
New Hampshire (1)			pre-1984	11/13/11	
New Jersey (13)	pre-1984				
New York (14)	pre-1984				pre-1984
North Carolina (2)	pre-1984		12/1/95	12/1/11	
Ohio (6)			4/8/04		
Oklahoma (1)			1/1/96	11/1/06	
Oregon (3)		8/9/2015	1/1/90		
Pennsylvania (8)		10/11/95	6/17/89	8/29/11	
Rhode Island (1)		pre-1984	pre-1984		
Tennessee (2)		5/10/94–11/1/98	10/1/96	5/22/07	
Texas (6)			1/1/96	9/1/07	
Utah (1)			5/1/95	3/1/94	
Virginia (3)			5/5/95		
Washington (4)		12/4/14	pre-1984		
Wisconsin (2)			11/1/11		
Total states with law during study period (total # of changes)	9 (3)	10 (9)	27 (22)	18 (18)	6 (5)

ABSTRACT.

1. The sentencing beginning “PTP laws were associated with...” should be replaced with a sentence that reads “PTP laws were associated with an 11% reduction in

RESULTS.

1. Table 1 should be deleted and replaced with the corrected Table 1 below.
2. Table 2 should be deleted and replaced with the corrected Table 2 below.

Table 2

Effects of Firearm Laws on Firearm Homicide in Large, Urban U.S. Counties, 1984–2015.

	IRR ^a	95% CI ^b
Permit to Purchase	0.89	0.85–0.93
Comprehensive Background Check only	1.10	1.08–1.13
Right to Carry	1.07	1.05–1.09
Stand Your Ground	1.08	1.05–1.10
Violent Misdemeanor prohibitions	1.24	1.21–1.27
County-level % Population African American Male Youth	1.55	1.51–1.60
County-level Poverty Rate	1.00	1.00–1.00
County-level Unemployment Rate	1.00	1.00–1.01
State-level Incarceration Rate	1.00	1.00–1.00
State-level Law Enforcement Expenditures	0.99	0.99–0.99
^a Incidence Rate Ratio		
^b 95% Confidence Interval		
Note: The model also included year fixed effects		

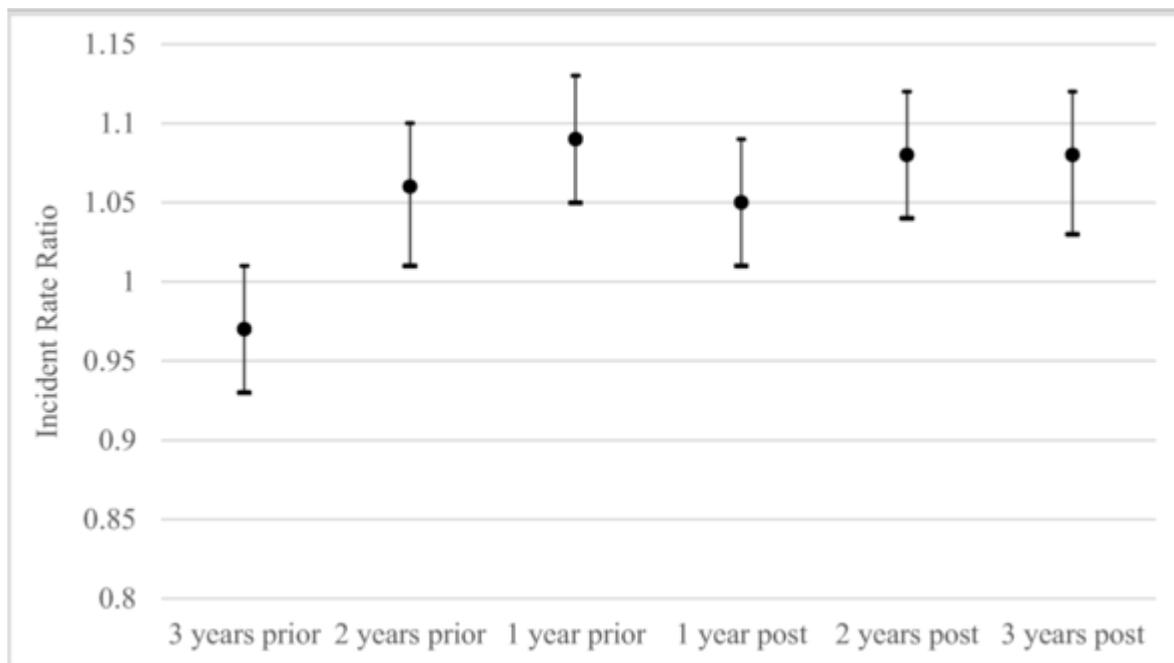
3. The second paragraph (describing the regression results in Table 2) should be deleted and replaced with the following: “Table 2 presents the effects of the firearm policies we examined on firearm homicide in large, urban counties after controlling for identified covariates. PTP laws were associated with an 11% reduction in firearm homicide (IRR = 0.89, 95% CI 0.85—0.93). CBC-only laws were associated with a 10% increase in firearm homicide (IRR = 1.10, 95% CI 1.08—1.13). RTC laws were associated with a 7% increase in firearm homicide (IRR = 1.07, 95% CI 1.05—1.09). SYG laws were associated with an 8% increase in firearm homicide (IRR = 1.08, 95% CI 1.05—1.10). VM laws were associated with

a 24% increase in firearm homicide (IRR = 1.24, 95% CI 1.21—1.27). When we included the proxy for county-level firearm ownership, there were negligible differences in the point estimates; however, the firearm ownership proxy itself was associated with a 40% increase in firearm homicide (IRR = 1.40, 95% CI 1.29—1.53)."

4. Figure 1 should be deleted and replaced with the corrected Fig. 1 below.

Fig. 1

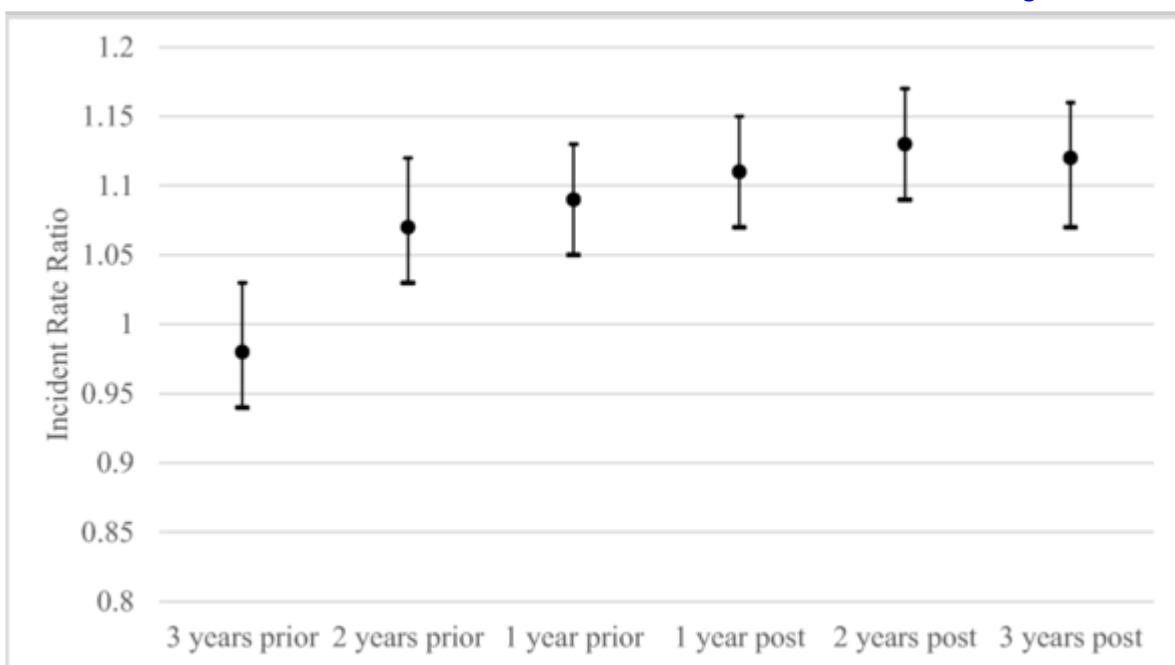
Effects of CBC-only laws on firearm homicide 1, 2, and 3 years pre- and post-enactment.



5. Figure 2 should be deleted and replaced with the corrected Fig. 2 below.

Fig. 2

Effects of VM laws on firearm homicide 1, 2, and 3 years pre- and post-enactment.



6. Table 3 should be deleted and replaced with the corrected Table 3 below.

Table 3

Effects of Firearm Laws on Non-Firearm Homicide in Large, Urban U.S. Counties, 1984–2015.

	IRR ^a	95% CI ^b
Permit to Purchase	1.02	0.95–1.09
Comprehensive Background Check only	0.94	0.91–0.99
Right to Carry law	1.04	1.01–1.07
Stand Your Ground	1.01	0.98–1.05
Violent Misdemeanor prohibitions	1.04	1.00–1.08
County-level % Population African American Male Youth	1.53	1.48–1.59
County-level Poverty Rate	1.01	1.00–1.02
County-level Unemployment Rate	0.99	0.99–1.00
State-level Incarceration Rate	1.00	1.00–1.00
State-level Law Enforcement Expenditures	1.00	1.00–1.00

^aIncidence Rate Ratio

^b95% Confidence Interval

Note: The model also included year fixed effects

7. The last paragraph (presenting results of Table 3) should be deleted and replaced with the following: “Table 3 presents the effects of the same set of firearm policies on non-firearm homicide rates. PTP and SYG were not associated with statistically significant changes in non-firearm homicide. CBC-only laws were associated with a 6% decrease in non-firearm homicide (IRR = 0.94, 95% CI 0.91—0.98). RTC laws were associated with a 4% increase in non-firearm homicide (IRR = 1.04, 95% CI 1.01—1.07). When we included the proxy for county-level firearm ownership, there were negligible differences in the point estimates; however, the firearm ownership proxy itself was associated with a 17% reduction in non-firearm homicide (IRR = 0.83, 95% CI 0.73—0.93).”

DISCUSSION.

1. The second sentence of the third paragraph should be deleted and replaced with the following: “Counties in states with RTC laws experienced a 7% increase in firearm homicide relative to counties in states with more restrictions on the issuance of concealed carry weapons permits.”
2. The second sentence of the fourth paragraph should be deleted and replaced with the following: “Counties in states with SYG laws experienced an 8% increase in firearm homicide.”

Declaration Exhibit 8

The Initial Impact of Maryland's Firearm Safety Act of 2013 on the Supply of Crime Handguns in Baltimore



CASSANDRA K. CRIFASI, SHANI A.L. BUGGS,
SEEMA CHOKSY, AND DANIEL W. WEBSTER

This study assesses the impact of Maryland's Firearm Safety Act (FSA) of 2013 on indicators of diversion of handguns to prohibited persons. Interrupted time-series analyses were conducted, and the findings were supplemented by results from a survey of men on parole and probation regarding Baltimore's underground gun market. The FSA was associated with an 82 percent reduction in police recovery of handguns with strong indicators of diversion (IRR=0.18, p=.005). Forty-one percent of survey respondents reported having more difficulty getting a handgun after the FSA because of increased cost, lack of trusted sources, or people less willing to engage in straw purchases on their behalf. These findings are consistent with the theory that the FSA reduces the diversion of handguns into the underground market.

Keywords: underground market, gun policy, diversion

The potential effectiveness of gun sales laws rests not only on individuals at high risk of committing harm with guns being prohibited from purchasing or possessing guns, but also on how well the laws prevent the diversion of guns to prohibited persons. Various laws have been put in place to prevent the diversion of guns to prohibited persons. The foundation of these laws includes requirements that purchasers pass background checks and sellers main-

tain records of purchaser information, dates of sale, and the specifics of the guns, including serial numbers. These requirements allow law enforcement to trace guns they recover from criminal suspects or crime scenes to the original retail sale and, in some cases, even subsequent sales.

Research demonstrates that laws designed to prevent such diversion by increasing the accountability of gun sellers and buyers are as-

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sociated with lower levels of guns diverted to prohibited persons in cross-sectional studies. These laws include permit-to-purchase (PTP) laws for handguns, the extension of background check requirements to gun transfers between private parties, mandatory reporting of lost or stolen guns by owners, and strong regulation and oversight of licensed gun dealers (Webster, Vernick, and Bulzacchelli 2009; Webster et al. 2013; Pierce, Braga, and Wintemute 2015).

Current federal laws include many weaknesses that allow guns to be diverted to prohibited persons with relatively little risk to sellers (Webster and Wintemute 2015). Many states have passed laws that attempt to address deficiencies in federal law by extending background checks and record-keeping requirements—and in some cases gun theft reporting requirements—to transfers made by private gun owners. Nine states and the District of Columbia also have some form of licensing system for handgun purchasers that outlaws the transfer of a handgun to anyone who does not have a valid PTP. Because scofflaw retail gun dealers can potentially divert large quantities of guns to criminals over time, and federal law and oversight are somewhat weak, some states also have their own regulation of licensed gun dealers.

Studies of the diversion of guns for criminal use necessarily rely on crime gun trace data from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF). These data provide information on the state of retail sale, state of crime involvement, whether the retail purchaser and the criminal possessor were the same person, and the dates the guns were first sold and then recovered by law enforcement. These dates allow ATF to generate a time-to-crime (TTC) for traced guns. The national average TTC for traced guns in 2015 was 10.48 years; Maryland's was 12.39 years (ATF 2016a). A gun recovered within one year of retail sale indicates to law enforcement that the gun was likely purchased with the intent of diverting that gun to a prohibited person (ATF 2002). The use of crime gun trace data to evaluate the diversion of guns to prohibited persons has gained increasing research support and validity, and supply-side constraints, such as requiring a PTP for hand-

gun purchasers, are associated with reduced likelihood of the diversion of guns (Braga et al. 2012; Webster, Vernick, and Hepburn 2001).

Because most of the relevant laws have been in place for decades and few cities consistently traced the origins of the guns they recovered in crime before the late 1990s, opportunities to examine whether changes in these laws result in changes in indicators of diversion of guns for criminal use have been limited. Recent studies of changes in PTP handgun laws in Connecticut, which implemented its law along with universal background check requirements in 1995, and Missouri, which repealed its PTP law in 2007, provide evidence that these laws reduced criminal access to guns and homicides committed with guns. Using analytic methods to create so-called synthetic controls for Connecticut's gun and nongun homicide rates to estimate counterfactuals for the first ten years following the implementation of the law requiring background checks and PTP for all handgun purchases, researchers estimated that the law was associated with a 40 percent reduction in gun homicide rates over the first ten years it was in place (Rudolph et al. 2015). A separate study estimated that Missouri's repeal of its PTP law was associated with a 14 percent increase in murders during the first five full years after the law's repeal, with the effects specific to events involving guns (Webster, Crifasi, and Vernick 2014). Missouri's repeal of its PTP handgun law was also followed by a twofold increase in the percentage of crime guns with very short intervals between retail sale and crime involvement and a large increase in the share of crime guns from sales originating within Missouri versus other states (Webster et al. 2013). Another study provides evidence that the repeal was associated with increased risk of law enforcement officers being shot in the line of duty in ways consistent with PTP laws being protective against criminal gun use (Crifasi, Pollack, and Webster 2015).

In 1996, Maryland enacted a law that made all handgun transfers, including those made by a private seller, contingent on the purchaser passing a background check. In 2013, Maryland lawmakers enacted the Firearm Safety Act (FSA), which has multiple components that could potentially reduce diversion of guns into

the hands of prohibited persons. These include requiring a PTP for anyone purchasing a handgun from either a licensed gun dealer or a private owner, expanding authority for state police to act against gun dealers found to have violated state gun sales laws (such as fines or license suspension or revocation), and mandating that gun owners report within seventy-two hours any theft or loss of a regulated gun. Additionally, the FSA bans the sale of assault rifles, limits magazine size to ten rounds, and bars persons who receive probation before judgment for violent crimes from possessing guns.

The PTP provision requires prospective purchasers to obtain a license issued by Maryland State Police, contingent on their passing a background check and completing a four-hour safety training course conducted by an approved and registered instructor. Individuals who were registered handgun owners before the FSA went into effect are exempt from the safety training requirement. Applicants for the license must also be fingerprinted during the application process by certified vendors that submit digital images of the prints to the Maryland State Police.

This article assesses the impact of Maryland's FSA of 2013 on the underground gun market in Baltimore. We analyzed data from handguns recovered by police and submitted for tracing to assess whether the new law was associated with fewer crime handguns recovered shortly after a retail sale from someone other than the retail purchaser, and an increase in the number of recovered crime handguns initially purchased in other states. To assess the perceived impact of the FSA on the underground gun market, we supplemented the analysis of crime handgun trace data with a qualitative evaluation of knowledge of the FSA and the perception among individuals prohibited from purchasing or possessing guns—Baltimore City residents currently on parole or probation—of changes in gun accessibility following the implementation of the FSA.

METHODS

Data on guns recovered by police and submitted for tracing were obtained from the Baltimore Police Department (BPD) for the period from January 1, 2007, through September 30,

2015. When a gun trace was successful, the data included information on original sale date and purchaser, recovery date, possessor, and the type of incident in which the gun was recovered. Gun trace data were excluded from our analyses if the incident in which the gun was recovered was recorded as "found/recovered property" or as "safe-keeping/turn in/buy-back." Such weapons were excluded so that only guns recovered in a crime were included in the dependent variable, making the analysis as specific as possible in testing the law's effect on the diversion of guns to criminals. Additionally, because most guns used in crime are handguns, and the FSA specifically licenses handgun purchasers, analyses were restricted to handguns.

We obtained data from Maryland State Police by month and year on the number of gun registration applications approved during the study period to have a proxy measure for the number of handguns also at risk for diversion to the underground gun market during the month and year a crime handgun was sold.

Because of legal restrictions on the sharing of crime gun trace data, simply no data are available at this granular level to generate an appropriate city-level comparison. The only available data are state-level reports of crime gun recoveries published by ATF; these reports, however, do not distinguish between types of guns (handgun or long gun), and they do not provide information on source state for short TTC guns, on whether the criminal possessor was the original purchaser, or in what month the gun was sold. These data elements are key to evaluating the effect of the FSA on the diversion of guns into the underground market. Thus, though we do present some state-level descriptive data, our time-series analyses are restricted to crime handguns recovered by police in Baltimore City and submitted for tracing.

Analytic Methods

We used an interrupted time-series design to test whether any changes were significant in key indicators of handgun trafficking or diversion of handguns for criminal purposes coincident with the implementation of the FSA on October 1, 2013. Similar to studies on gun trafficking or diversions of guns to individuals who

used those guns in crime, ours examined two trafficking indicators—short TTC following a retail sale and the percentage of crime guns initially sold by out-of-state retailers.

We used four outcomes with monthly time series: the number of handguns originally sold in Maryland with a TTC of less than one year; the number of handguns originally sold in Maryland with a TTC of less than one year and the criminal possessors were not the purchasers of record; the number of handguns originally sold by out-of-state gun dealers; and the number of handguns originally sold by out-of-state gun dealers and the criminal possessors were not the purchasers of record.

For the less than one year TTC outcomes, observations were based on the month the handgun was sold, which enabled us to categorize whether a handgun used in crime had been sold under FSA rules. Measures that involved handguns recovered from someone other than the lawful purchaser allowed for a direct assessment of the FSA's effect on the diversion of handguns for criminal purposes. Our hypothesis was that the FSA would be associated with reductions in measures of guns that originated in Maryland. If that proved true, we hypothesized a modest increase in measures of guns originating outside of Maryland as individuals seeking handguns for criminal use pursued alternatives to new handguns originating from retail sales in Maryland.

Interrupted time-series analyses were performed on crime handgun trace data to discern whether the implementation of the FSA was associated with changes in the outcomes described above. Negative binomial regression models were used due to overdispersion in the data (likelihood ratio test of alpha=0, $p<.05$). We controlled for baseline trends in the outcome variables in two ways, with year fixed effects and a linear trend term. Indicator variables for calendar month were evaluated for inclusion to adjust for potential seasonality in the outcome variables.

The number of less than one year TTC handguns recovered by police may be influenced by policing practices that vary over time with respect to the degree to which arrests for illegal gun possession are prioritized. Therefore, we controlled for variation in the mean number

of all handguns recovered by the BPD during the twelve months following a sales month observation, t . Because of the short observation period following the law's implementation and the truncated follow-up period such that handguns sold after October 1, 2014, have less than one year in which they would be at risk of recovery by the BPD, we included a covariate to measure exposure for the number of months a handgun was at risk of being recovered in a crime.

Because of the limited control variables available, and the lack of an appropriate comparison jurisdiction with the same granular-level crime gun trace data, we evaluated our data's pre-intervention stationarity using autoregressive integrated moving average modeling. The autoregressive component to our outcome variables was significant; however, the inclusion of monthly gun recoveries accounted for the lack of stationarity and made the autoregressive component nonsignificant. We were therefore confident in our use of an interrupted time-series model with negative binomial regression controlling for monthly crime gun recoveries.

We also ran the models with and without a control for the number of gun registration applications approved during the month of a crime handgun's sale that originated in Maryland. An argument can be made for excluding approved gun applications from the regression models because it could partly mediate the effect of the FSA on handguns diverted for criminal use and bias estimates of the full effect of the new policies. We therefore present findings with and without controls for changes in the volume of gun purchase applications.

The estimated effects from the interrupted time-series analyses are presented as incident rate ratios (IRR) with 95 percent confidence intervals. Analyses were conducted using Stata IC version 14.2 (StataCorp 2015).

Survey Methods

To assess awareness and perceived impact of the FSA among persons legally prohibited from purchasing or possessing guns, we included four FSA-specific questions in a multipart survey designed to appraise gun availability in the underground gun market in Baltimore. Using

a convenience sampling methodology, we administered the survey in May and June 2016 to 195 men on parole or probation in Baltimore. The selection was to identify persons with recent interaction with the criminal justice system that would prohibit them from purchasing or possessing a gun under Maryland state law.

Survey respondents were recruited outside parole and probation offices in Baltimore. Men who asserted that they were over the age of eighteen, currently on parole or probation, and Baltimore residents were invited to complete the survey after eligibility was determined via screening questions. All participants were anonymous volunteers. If an individual met the eligibility criteria and was interested in participating, research assistants escorted him to a semiprivate location where he received additional information and specific instructions about the study.

Both the informed consent process and the survey were self-administered using a closed-ended computerized survey instrument with audio assistance to ensure confidentiality and prevent issues of low literacy from affecting participation. This methodology allowed for uniform and anonymous collection of data related to the underground gun market that would be otherwise difficult to obtain. Research assistants, who were trained in participant recruitment, supervised the survey completion and provided technical assistance when needed. The survey process took approximately thirty minutes. The four survey items specifically related to the FSA asked whether respondents perceived that the new law affected the following factors:

- the difficulty of obtaining a gun generally,
- the cost of a gun,
- the willingness of another individual to buy a gun on the respondent's behalf (a straw purchaser), and
- the ease of finding a trusted source that would sell a gun to the respondent.

A respondent who answered yes, to indicate that the law made it more difficult to obtain a gun, was presented with a narrative text box to provide detail on how the law made obtaining

a gun more difficult. This study was approved by the Johns Hopkins Institutional Review Board.

RESULTS

The results are comprised of an analysis of BPD's crime gun trace data and surveys of prohibited purchasers in Baltimore City.

Crime Gun Trace Data

Over the study period, BPD submitted 21,546 guns for tracing. Of these, 6,520 were found guns or guns turned in by citizens and 5,476 were rifles or shotguns; these categories were excluded from the analysis. Data for 11,462 handguns that were connected to a criminal suspect, crime scene, or criminal investigation were submitted for tracing. More than half (55.6 percent) of the handguns were recovered in arrests for illegal handgun possession; 20.3 percent were recovered in drug-related arrests; and 17.8 percent were connected to some type of violent crime (see table 1).

Table 2 shows, by year, the total crime handguns recovered by BPD as well as the number and percentage that could be traced to the state of original retail sale. The number of handguns recovered and submitted for tracing declined through the study period. The proportion of handguns recovered by BPD that originated in Maryland hovered around 45 percent from 2007 to 2012, but declined gradually starting in 2013.

During the study period, Maryland State Police processed and approved 441,882 gun registration applications. Figure 1 presents the trend for the number of approved applications per month. A sharp increase occurred in late 2012, followed by a huge spike in purchase applications just before FSA implementation.

Figure 2 depicts a three-month moving average of the number of handguns that originated in Maryland and were recovered within one year of retail sale when the purchaser was someone other than the criminal possessor. The monthly count of crime handguns diverted within a year of retail sale hovered around a mean of two from 2009 through the first half of 2013 and then spiked in the third quarter of 2013, just before the FSA went into effect. The indicator then fell to less than one

Table 1. Handguns Recovered, January 2007 to September 2015

Crime Category	Number (n=11,462)	Percentage with Offense Type Listed (n=11,131)
Assault	910	8.2
Carjacking	48	0.4
Illegal discharge of firearm	67	0.6
Discharge (police involved)	15	0.1
Domestic assault	15	0.1
Drug related	2,252	20.3
Handgun violation	6,191	55.6
Homicide or attempted homicide	289	2.6
Homicide or attempt (police involved)	33	0.3
Nonfatal shooting/attempt	584	5.2
Nonfatal shooting or attempt (police involved)	97	0.9
Property crime	106	1.0
Questionable death	49	0.4
Rape/sex offense	15	0.1
Other	166	1.5
Missing	331	

Source: Authors' calculations based on Baltimore Police Department crime gun trace data.

Table 2. Crime-Involved Handguns Recovered, January 2007 to September 2015

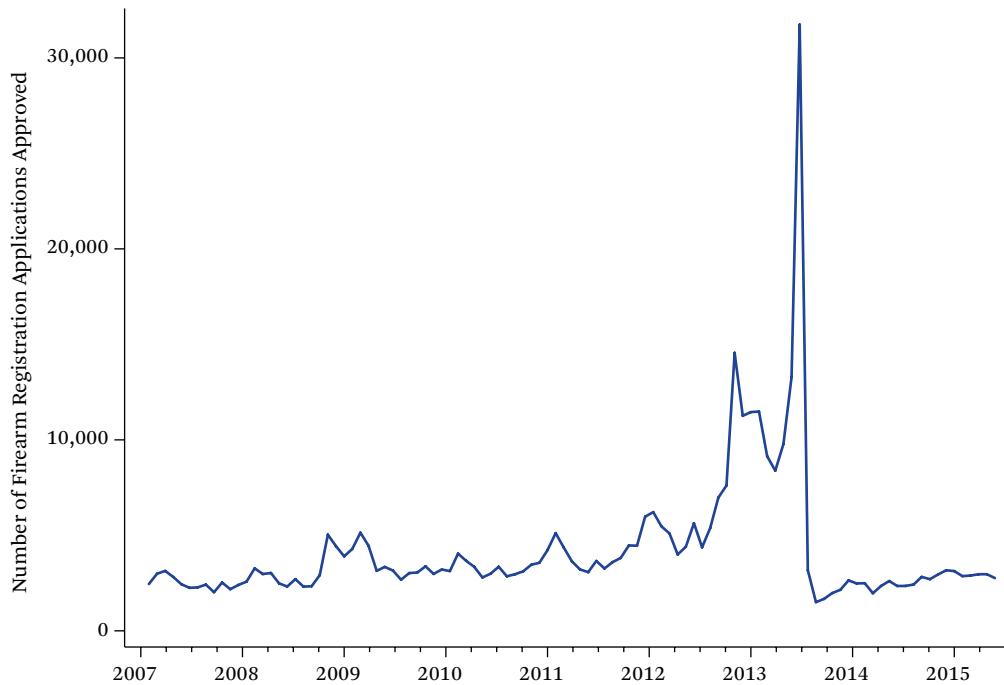
Year	Total Recovered:		Traced to State of Retail Sale: n (percent)
		n	
2007	1,527		1,193 (78)
2008	1,383		1,046 (76)
2009	1,370		1,082 (79)
2010	1,308		1,027 (79)
2011	1,243		976 (79)
2012	1,202		1,012 (84)
2013	1,162		915 (79)
2014	1,238		929 (75)
2015 ^a	1,029		845 (82)
Total	11,462		9,025

Source: Authors' calculations based on Baltimore Police Department crime gun trace data.

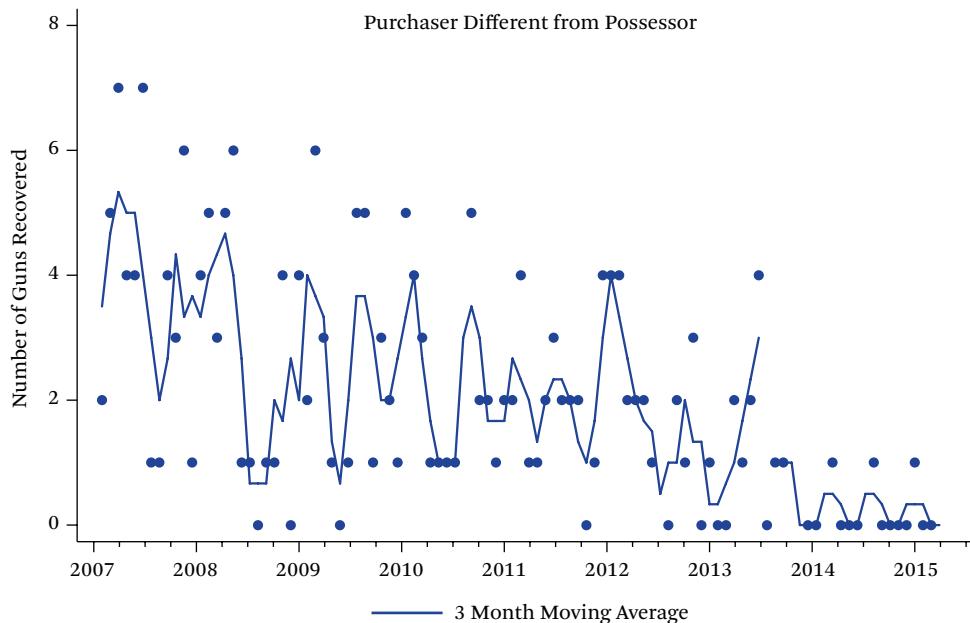
^a Data through September 2015.

per month after the FSA went into effect on October 1, 2013 (see figure 2). Overall, the mean number of handguns per month with TTC of less than one year for the retail sales period before the FSA was 6.0 (SD=3.31), dropped to 2.58 (SD=1.08) during the first twelve months the FSA was in effect, and then increased to 4.25 (SD=2.25) for the period between October 2014 and September 2015.

The results from the regression analyses are consistent with the hypothesis that the FSA would be protective against the diversion of guns into the underground market for criminal use (see table 3). For all handguns originally sold in Maryland that were recovered within one year of retail sale, the IRR for the FSA is 0.33 ($p=.001$), which translates to a 67 percent decline in this outcome. The FSA was associ-

Figure 1. Firearm Registration Applications Approved in Maryland

Source: Authors' calculations based on Baltimore Police Department crime gun trace data.

Figure 2. Handguns Sold in Maryland and Recovered in Criminal Incidents

Source: Authors' calculations based on Baltimore Police Department crime gun trace data.

Note: Within one year of retail sale, purchaser different from possessor.

Table 3. Estimated Effects of Maryland's Firearm Safety Act

Dependent Variable	FSA IRR (95 percent CI)	Overall Crime Gun Recoveries IRR (95 percent CI)	Linear Trend IRR (95 percent CI)
Guns sold in Maryland and recovered within one year of retail sale	0.33* (0.17 to 0.64)	1.03* (1.00 to 1.05)	1.00 (0.99 to 1.01)
Guns sold in Maryland and recovered within one year of retail sale and purchaser different from possessor	0.18* (0.05 to 0.60)	1.02 (0.99 to 1.06)	0.99 (0.98 to 1.01)
Guns sold outside Maryland	1.20 (0.61 to 2.37)	0.996* (0.99 to 1.00)	Year fixed effects used
Guns sold outside Maryland and purchaser different from possessor	1.13 (0.53 to 2.45)	0.996* (0.99 to 1.00)	Year fixed effects used

Source: Authors' calculations based on Baltimore Police Department crime gun trace data.

* $p < .05$

Table 4. Estimated Effects of Maryland's Firearm Safety Act, Controlling for Volume

Dependent Variable	FSA	Overall Crime Gun	Total MD Firearm Registration	Applications	Linear Trend
	IRR (95 percent CI, p)	Recoveries IRR (95 percent CI, p)	Approved IRR (95 percent CI, p)	IRR 95 percent CI, p)	
Guns sold in Maryland and recovered within one year of retail sale	0.41* (0.20 to 0.82)	1.02 (1.00 to 1.05)	1.00 (1.00 to 1.00)	1.00 (0.98 to 1.00)	0.99
Guns sold in Maryland and recovered within one year of retail sale and purchaser different from possessor	0.24* (0.069 to 0.84)	1.02 (0.98 to 1.05)	1.00 (1.00 to 1.00)	1.00 (0.97 to 1.00)	0.99

Source: Authors' calculations based on Baltimore Police Department crime gun trace data.

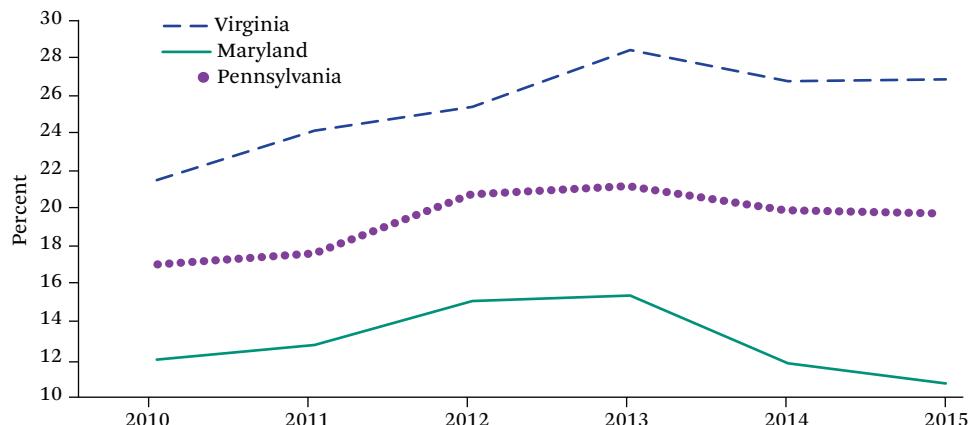
* $p < .05$

ated with an 82 percent reduction in the number of handguns originally sold in Maryland that were recovered within one year of retail sale and the purchaser was not the same as the possessor (IRR=.18, $p=.005$); this is a key indicator that a gun was purchased with the intent of diverting it for criminal use.

Controlling for the volume of gun registration applications approved in the month of a crime gun's sale (that is, how many handguns were at risk of being diverted for criminal pur-

poses at the time a crime handgun was sold) did not remarkably affect the magnitude or significance of the estimates for the FSA (see table 4). After controlling for pre-FSA trend, the estimated increase in the number of handguns recovered by police that were originally sold outside of Maryland was 20 percent but was not statistically significant (see table 3).

Figure 3 depicts the percent of guns (includes handguns and long guns) recovered in crime within one year of retail sale that were

Figure 3. In-State Crime Guns Sold Within Year of Crime

Source: Authors' calculations based on ATF 2016a.

originally sold in the state of recovery for Maryland, Pennsylvania, and Virginia. These numbers are not to the same granular level as that of the time series for Baltimore City. The state-level data do not differentiate between type of gun and do not contain information on whether the purchaser was the criminal possessor or the month of sale. All three states were on an upward trajectory for the percentage of in-state crime guns with a TTC of less than one year. However, after 2013, although the indicators for Pennsylvania and Virginia leveled off, Maryland saw a 30 percent decline (see figure 3). This data provides further support to the hypothesis that the FSA reduced the diversion of guns into the underground market.

Parolee-Probationer Surveys

In May and June 2016, we fielded an audio-assisted computer-based survey of men on parole and probation in Baltimore. Our research teams approached 448 men and screened 251 for eligibility (55 percent). Of those who were screened, 216 were eligible to participate and 195 completed the survey on their experiences with the underground gun market in Baltimore (91 percent).

Individuals completing the survey reported significant experiences with gun violence and the underground gun market. Sixty-three percent had been shot at one or more times in their lives, 48 percent had been shot at multiple times. Of the 122 men who had been shot

at, 43 percent had suffered gunshot wounds (see table 5). The most common reasons respondents had been most recently jailed were related to violence (32 percent) or drugs (28 percent).

Of the 195 respondents, 41 percent stated that it was more difficult to obtain a gun after the passage of the FSA (see table 6). Forty percent perceived that the new gun law affected the cost of guns in the underground market. In referencing how the FSA affected cost, respondents stated that, for instance, the law "made guns more expensive." The law was also perceived to have affected access to individuals willing to purchase guns on behalf of the survey respondents (34 percent) and access to a trusted source who would sell guns to the respondents (25 percent) (see table 6). Respondents made comments related to the difficulty of finding trusted sources such as "u [sic] have to have a permit" or "cause you don't always know the person that's [sic] selling the gun."

DISCUSSION

Several components of Maryland's Firearm Safety Act of 2013—a handgun purchaser licensing requirement, mandatory lost or stolen gun reporting by gun owners, and stronger regulation of retail gun dealers—were designed principally to prevent the diversion of handguns to prohibited persons and those seeking to acquire guns for criminal purposes. Findings from the analysis of handguns recov-

Table 5. Demographic Characteristics of Survey Respondents

Demographics	N=195	Percent
Age (mean [range])	38.7 (19–69)	
Race (n=179)		
African American	144	80
White	23	13
Multiracial	12	7
Relationship status (n=192)		
Never married	153	80
Married	19	10
Previously married	20	10
Currently employed (n=192)		
No	142	74
Yes	50	26
Education (n=191)		
Middle school	17	9
High school	95	49
GED	42	22
Some college	29	15
Associate's degree or higher	8	4
Ever shot at (n=192)		
Never	70	37
Once	28	15
Multiple times	91	48
Ever hit when shot at (n=122)		
Yes	53	43
No	69	57
Last six months, ever carried or used a gun		
Did not carry or use a gun	130	67
Carried but not used	34	17
Pointed or shown gun	6	3
Fired in the air	7	4
Fired at an individual	6	3
Other	12	6

Source: Authors' calculations based on underground gun market survey.

ered by Baltimore police are consistent with the theory that the FSA suppressed diversions of guns for criminal use. Indeed, the FSA was associated with an 82 percent reduction in the risk of a handgun being recovered from a criminal possessor who was not the retail purchaser less than twelve months after its retail sale in Maryland. The data suggest that the new legislation, most probably the licensing require-

ment for handgun purchasers, may have also contributed to a reduction in the number of legal purchasers subsequently involved in a crime with the gun. In further support of the theory that the FSA reduced diversion of handguns into the underground gun market, Maryland saw a 30 percent reduction in in-state handguns recovered in crime less than a year after retail sale. Pennsylvania and Virginia,

Table 6. Baltimore Underground Gun Market Survey Respondents' Perceptions of the Impact of Maryland's Firearm Safety Act.

Survey Question	N=192	Percent
Have the new laws made it more difficult to get a gun?		
Yes	79	41
No	104	54
Don't know	6	3
Refuse to answer	3	2
Have the laws affected the cost?		
Yes	77	40
No	102	53
Don't know	9	5
Refuse to answer	4	2
Have the laws affected the willingness of someone to buy a gun on your behalf?		
Yes	66	34
No	106	55
Don't know	15	8
Refuse to answer	5	3
Have the laws affected how easy it is to find someone you trust to sell you a gun? (n=191)		
Yes	48	25
No	129	68
Don't know	11	6
Refuse to answer	3	2

Source: Authors' calculations based on underground gun market survey.

neighboring states that did not change their laws, did not see a similar decline.

Forty percent of the survey respondents, who were prohibited under Maryland law from legally purchasing or possessing guns, reported that the new law made it more difficult to get guns. More than 30 percent indicated that the law affected the willingness of other individuals to purchase guns on behalf of the respondents. Additionally, 25 percent reported that the law affected the ease of finding a trusted source who would sell guns to the respondents. This is an important factor in the underground gun market. The ability to find a trusted source, or to continue trusting a previously used source, can greatly influence a prohibited individual's ability to acquire a gun (Cook, Parker, and Pollack 2015). Respondents in our survey, when asked how the law made

it more difficult to find a trusted source, said that they did not know whether they could trust the person or they were wary that the gun might have been stolen. Additionally, when asked how the law affected the willingness of a person to purchase a gun on the respondent's behalf, several respondents stated that purchasers now must have a permit and that laws are in place against straw purchases. These survey data, in conjunction with the analysis of the crime gun trace data, suggest that Maryland's FSA is reducing the diversion of guns to persons prohibited from legally acquiring or possessing them.

Although survey results indicate a possible deterrent effect of Maryland's FSA on access to guns among the prohibited persons interviewed, it is not possible from this study to statistically estimate an impact of the law on over-

all prohibited access to and use of guns. A shift toward a greater share of crime handguns from out of state following enactment of the FSA, however, might signal some degree of scarcity of handguns from local sources in Baltimore's underground market. As an example, federal and local law enforcement announced the arrest of a gun trafficking ring in December 2015 that was allegedly bringing thirty guns per week from Tennessee, where gun sales laws are much weaker than in Maryland, to gangs in Baltimore (Anderson 2015).

Additionally, the share of Baltimore crime handguns from states other than Maryland did increase steadily each year from 55 percent in 2012 (last full year before the FSA) to 64 percent through the first three quarters of 2015. The point estimate from our regression analysis indicated a 20 percent increase in out-of-state crime handguns recovered in Baltimore coincident with the FSA, but the change was not statistically significant. However, the nearly two-thirds of crime handguns in Baltimore traced to original out-of-state retail sales in 2015 further support the existence of notable constraints in the local supply lines to Baltimore's underground gun market (ATF 2016a).

The limited crime gun trace data publicly released by ATF greatly hampers the ability to draw conclusions about the effects of gun sales regulations, especially when juxtaposed against what our research team could do with the granular crime gun data used for this study, as well as in studies by other researchers using gun-level crime gun trace data supplied by local police (Cook et al. 2007; Cook et al. 2014). Discussions of the restrictions Congress has placed on access to ATF's crime gun trace data often focus on limiting law enforcement access and accountability of gun sellers, but these restrictions also hinder research that can inform gun policy decisions and enforcement efforts (Webster et al. 2012).

Although our analyses controlled for the overall number of crime guns being recovered by BPD and general baseline trends in the outcomes, as well as monthly gun registration application approvals before and after passage of the FSA, we did not have monthly handgun sales data to accurately measure and control for exposure risk for the number of handguns

sold in each month. However, one way the FSA provisions may affect the rate of crime involvement of handguns sold in Maryland is in decreasing sales volume.

An important historical confounder we could not control for was the uprising and civil unrest in April 2015 following the death of Freddie Gray, who died of injuries sustained in a BPD van after being arrested. The unrest was followed initially by a decrease in arrests, including a decline in handgun violations, and a historically steep rise in homicides and nonfatal shootings. Weapon arrests subsequently increased and the rate of increase of homicides and shootings slowed (Morgan and Pally 2016). These events likely influenced Baltimore residents' purchases of handguns and the probability that police would arrest someone for illegally carrying or using a handgun during the last five months of the study period, which could influence the relationship between the FSA and recovery of crime guns. Additionally, although this is a longitudinal study, the lack of an appropriate comparison group limits our ability to draw causal inference regarding the effect of the FSA on Baltimore's underground gun market.

In the future, additional years of post-FSA data should be examined to assess whether the ratio of in-state to out-of-state source crime guns continues to trend toward more out-of-state crime guns. When Missouri repealed its handgun purchaser licensing law in 2007, the share of in-state to out-of-state crime guns shifted gradually but steadily over time, such that in-state crime guns rose from 56 percent during 2006 to 74 percent in 2014 (ATF 2016b). This increase coincided with an increase in gun homicide rates and police officers shot in the line of duty, suggesting that laws somewhat similar to the FSA affect criminal access to and use of guns (on rate change, Webster et al. 2014; on officers killed, Crifasi, Pollack, and Webster 2015).

This study offers an evaluation of the impact of the FSA both on indicators of diversion of handguns for criminal purposes and perceptions of the law's impact on the underground market by those prohibited from purchasing or possessing guns. The FSA appears to have constrained the local supply of illegal hand-

guns in Baltimore. Fewer handguns were being recovered with indicators of diversion (short TTC and a different purchaser and possessor), and prohibited purchasers in Baltimore (men on parole or probation) reported increased difficulty in obtaining guns. These findings are consistent with previous literature evaluating the effect of state laws designed to reduce diversion of guns to criminals.

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